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ADDENDUM ET CORRIGENDUM.

Page 267, Figure 1, explanation. For *Rhynchœlaps smithii*, sp. nov. read *Rhynchœlaps roperi*, sp. nov.

Page 308, paragraphs 3 and 5. The late W. W. Thorpe in discussing aboriginal stone files says "Referring once more to Mr. [W. J.] Enright for written detail, on August 1st, 1931, he communicated as follows: 'I do not remember the name my aboriginal informant gave me for the implement you mentioned, but I am endeavouring to find out for you. The information as to the use of this implement came from the head man named "Tony", who was king of the Kutthung (Port Stephens district)." Mr. Enright inadvertently overlooked the fact that in a paper by himself published in the *Journal and Proceedings of the Royal Society of New South Wales*, Vol. xxxiv, 1900, entitled "The Language, Weapons, and Manufactures of the Aborigines of Port Stephens, N.S.W.", he listed, on page 111, "Dip-oon′-gâ, *a stone used for sharpening shell fish-hooks*", the word sought for.

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LIST OF CONTRIBUTORS.

A NEW SPECIES AND SUB-SPECIES OF FRUIT-BATS (*PTEROPUS*) FROM THE SANTA CRUZ GROUP.

By

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During a collecting expedition amongst some of the islands of the Santa Cruz Group from July to August, 1926, when Mr. A A. Livingstone and myself had the good fortune to be guests of Mr. N. S Heffernan, then District Officer of the Group, a very interesting collection of fruit-bats representing three species was obtained. Apart from the historical importance of Vanikoro Island because of the loss there in 1788 of La Pérouse's two ships, great zoological interest attaches to the fateful spot owing to the visitation of the famous naturalists Quoy and Gaimard, the first to make scientific observations and collections in that region. Their collections were naturally very incomplete and also subject to considerable confusion, as later researches in various branches have shown, doubtless owing to the conditions of work and storage aboard the "Astrolabe," as well as to the fact that the range of individual forms would not then be considered of so much importance.

Of the fruit-bats, the large and small species occurring on Vanikoro retain the maximum interest owing to the confusion in which they have become involved. The history of the two forms has been detailed by Andersen,[1] by whom doubt was cast upon the occurrence there of the smaller form, which he considered may have come from the Marianne Islands. This history was also reviewed in my paper,[2] in which specimens collected at Vanikoro by Livingstone and myself definitely fixed that island as the habitat of *Pteropus tuberculatus*.

Specimens of the larger Vanikoran species were also obtained by us at Santa Cruz Island, and the nearby Reef Islands Much to our disappointment we were unable to call at the outlying and seldom visited island of Tikopia, but later, Dr. Raymond Firth, well-known New Zealand anthropologist, very kindly took a collecting can on behalf of the Trustees, and collected a fine series of ten large bats and some birds, while engaged upon his researches there. These specimens from the various islands of the Group, constituting a series of twenty-six, confuse the issue regarding the larger Vanikoran species described as *P. vanikorensis* by Quoy and Gaimard, as the minimum dimensions of the recent very extensive series greatly exceed the external dimensions given by Andersen for *vanikorensis*, while certain cranial and dental measurements, particularly the lengths of the upper and lower molar rows, make it clear that two different forms are indicated.

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[1] Andersen.—*Cat. Chiroptera, Brit. Mus.*, 1, 1912, p. 310.
[2] Troughton.—REC. AUSTR. MUS., xv, v, 1927, pp. 355-6

That a certain amount of confusion existed in the French naturalists' material is shown by the fact that they erroneously associated a skull of *P. tuberculatus* with their much larger *vanikorensis*. It was owing to this error that Andersen discredited the occurrence of the former at Vanikoro, but, as our material definitely established the presence there of *tuberculatus*, it appears, as shown above, that it is unfortunately the occurrence of *vanikorensis* which is in doubt, contrary to Andersen's interpretation of the matter.

According to Andersen when discussing the habitat of *tuberculatus*, "So much only is sure, that Vanikoro and Guam are the only places visited by the 'Astrolabe' in which it can have been obtained." If this contention be also applied to *vanikorensis*, coupled with the fact that its external and, with one exception, cranial dimensions thoroughly accord with those of *P. mariannus* of Guam and other islands of the Marianne Group, there would seem to be no alternative to regarding *vanikorensis* as wrongly attributed to the Island of Vanikoro. Andersen separated the eight species of his *Pteropus mariannus* group of the genus into relatively smaller-eyed North Pacific and larger-eyed South Pacific forms, and it is the size of the orbit only which allies *vanikorensis* with the generally much larger southern forms. Therefore, in view of the fact that all other dimensions fail to agree with the larger form taken by us, one can only suppose that Quoy and Gaimard's specimens came from some other locality, and that Andersen, possibly influenced by the specific name, placed undue value upon the character of the orbital diameter; it may be noted that only one skull of the four specimens of *vanikorensis* was measured, and for the present it can only be conjectured that either the dimensions may vary considerably, that the specimen was abnormal, or that it came from a hitherto unsuspected locality, such as an outlying island of the Marianne Group.

Whatever proves to be the solution of the problem, the skin and skull dimensions of our material collected personally on Vanikoro fail to accord with those of *vanikorensis*. In view of the improbability of the occurrence of two such closely allied forms in the one place, or that we should have failed to secure the smaller of the two at Vanikoro or any other of the islands at which the larger one was secured, there is little doubt that the smaller, as represented by *vanikorensis*, is not an inhabitant of the Santa Cruz Group.

The larger-eyed South Pacific forms, apart from the very doubtful occurrence of *vanikorensis*, are *Pt. tonganus* Quoy and Gaimard, and *Pt. geddiei* MacGillivray. In his remarkable catalogue Anderson has stated that all three are closely related and chiefly characterized by size of wing, *tonganus* being diagnosed as "Similar to *Pt. vanikorensis*, but rather larger and with relatively longer wings" and *geddiei* as "Similar to *Pt. tonganus*, but skull, teeth, and external dimensions larger." As my Santa Cruz specimens of this group of the genus have external dimensions averaging larger than *geddiei*, said to be "the largest form of the group," and therefore greatly in excess of those recorded for *vanikorensis*, they are regarded as representative of a new form to be described below; in view of the close relationship and intergradation shown it is considered desirable to regard the Santa Cruz material and *Pt. geddiei* of the New Hebrides and New Caledonia as only sub-specifically distinct from *Pt. tonganus*.

Andersen has regarded it as axiomatic that "When two or more species of *Pteropus* occur together in one place, they are generally conspicuously different

in size," which proved to be the rule on Santa Cruz Island, where our party secured a series of a beautiful light-coloured species of the *Pt. hypomelanus* group, which has apparently not been described hitherto.

Pteropus tonganus heffernani sub-sp. nov.

Diagnosis.—Apparently quite similar in general coloration to the typical form but the external measurements average larger, and the cranial and dental dimensions display considerable differentiation. Length of the second digit metacarpal 76·5–88 mm., as opposed to 72·5–79 mm. in *Pt. geddiei*; width across canines (externally) greater, 15·5–16 as opposed to 13·7, and width between p^4–p^4 (internally) less, 9·3–9·7 compared with 10·8 in *geddiei*. The maximum dimensions of m_1 in the holotype and allotype are 5·9 × 3·9 compared with 5·2 × 3·8 mm. for *geddiei*. Forearm 148–168 mm.

Palate-ridges.—Arrangement normally as in *tonganus* and described for the *Pt. hypomelanus* group. The male and female types from Tikopia show traces of the additional ridge between the normal 9th and 10th.

Colour.—Apparently quite as described for *geddiei*, which Andersen regarded as intergrading with *Pt. tonganus*.

Range and specimens examined.—A series of twenty-six, including sixteen collected by Messrs. E. Le Troughton and A. A. Livingstone of the Australian Museum Staff at Vanikoro and Santa Cruz Islands and the nearby Reef Islands, all of the Santa Cruz Group, and ten collected at the adjacent island of Tikopia by Dr. Raymond Firth. Male holotype No. M.4646, and female allotype M.4652 in the collection of the Australian Museum; collected and donated by Dr. Raymond Firth.

This apparently distinct sub-species is named in honour of Mr. N. S. Heffernan in appreciation of his great hospitality and assistance to the Museum officers during their expedition to the Santa Cruz Group.

Though it is possible that *Pt. vanikorensis*, when its definite habitat is known and the typical material can be studied in more detail, may also prove to be a sub-species of *tonganus*, it is most significant that, although one has collected bats of the *Pt. mariannus* group from four localities in the Santa Cruz islands, they are all much larger than the type series of *vanikorensis*, and that one found no trace on Vanikoro Island of specimens reconcilable with the dimensions of that species.

Pteropus sanctacrucis sp. nov.

Diagnosis.—Allied to *Pt. colonus* from the more distant West Solomons by its comparatively naked tibia and shorter m^1, while it is thus separated from the nearer *Pt. solomonis* of the Central Solomons, which has a thickly furred tibia and a longer m^1. It differs from both the above by having a longer forearm and narrower ears. Forearm 112–121 mm.

Skull.—Comparative dimensions show the rostrum to be shorter and broader than in either of the allied species, while the skull is also generally broader; the interorbital constriction is decidedly broader than in either, the palate being especially broader than in *colonus*. The mandible is distinguished by being shorter and having a higher coronoid process than in either ally.

Dentition.—The length of the molar rows allies it with *solomonis*, and the length of molar^1 with *colonus*.

External characters.—The ear, laid forward, extends about two-thirds of the distance to the posterior canthus of the eye. Tibia naked above in the holotype male save for a few scattered hairs; very sparsely haired in the female. Interfemoral distinctly continuous behind, from 3–7·5 mm. in depth. Wing attachments about 14 mm. apart.

Colour.—Males of a darker coloration throughout; back, rump, and crown of a shining golden-brown. Mantle rich russet, the colour extending around to the breast. Cheeks russet-brown sprinkled with greyish hairs. Belly soft wood-brown. The females, which are of a considerably paler coloration, have the back and crown of a pale golden-yellow, the mantle a light shade of cinnamon-brown, contrasting but little and reduced to an indefinite band, which is weakest in the centre. Cheeks and sides of neck as dark as the slight mantle, with a light yellow area around the eye. On the undersurface the ochraceous-buff of the upper chest extends down the centre; sides of belly pale wood-brown washed with light to warm buff.

Measurements.—The holotype male in spirits: forearm 118·5; 3rd digit metacarpal 80·5; 5th digit metacarpal 85; ear, length from orifice 20·5, maximum width flattened 14·8; lower leg 49·3; foot 39·5.

Skull of allotype female: total length to gnathion 54; palation to incisive foramina 24·5; front of orbit to tip of nasals 14·3; zygomatic width 32·5; width across m^1 (externally) 15·9; width across canines (externally) 13; interorbital constriction 8·6; orbital diameter 12·5; mandible length 40·9, coronoid height 23; teeth, upper c-m^2 20, lower c-m$_3$ 22; upper incisors, combined width, 7; dimensions of m^1, 4·5 × 2·7 mm.

Specimens examined.—A series of seven specimens from Santa Cruz Island, Santa Cruz Group, collected by Messrs. E. Le G. Troughton and A. A. Livingstone. Male holotype registered No. M.4763 and the female allotype No. M.4761 in the Australian Museum collection.

This delicately coloured and apparently quite distinct species of the *Pt. hypomelanus* group was observed and taken only on Santa Cruz or Ndeni Island; this island, from which the group takes its name, was discovered by the Spanish navigator Alvaro de Mendana in 1595 when an ill-fated attempt at settlement was made.

STUDIES IN AUSTRALIAN ATHECATE HYDROIDS.

No. III. THE HISTOLOGY OF *Myriothela harrisoni*, BRIGGS.*

By

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(Plates i-iii, and Figure 1.)

INTRODUCTION.

In Part I of this series of "Studies in Australian Athecate Hydroids," I described and figured the external characters of a new species of *Myriothela*, *M. harrisoni*, from the South Coast of New South Wales. The specimens, which were collected on the undersides of rocks below low-water mark at Bulli, were fixed in sublimate-acetic-alcohol and transferred to 70% alcohol. Serial sections of the hydranths with their attached blastostyles and gonophores were cut in a transverse direction, and afterwards stained with Ehrlich's hæmatoxylin followed by eosin. Grubler's picro-carmine proved a very useful stain for the differentiation of the fibrillar structure of the supporting lamella in the capitulum of the tentacles. For the study of the nematocysts, some of the sections were stained in methylene blue and orange G. The sections were cut in thicknesses varying from 6 to 8 μ.

In the present paper the histology of *Myriothela harrisoni* is described and figured, and particular attention paid to the form, structure, and distribution of the nematocysts since these bodies possess a special taxonomic significance in Kuhn's group of the Capitata.

Among the Athecate Hydroids, Broch[1] (1916) finds two characteristic principal forms of stinging capsules. In the Capitata there are large oviform or almost wholly spherical nematocysts, while the Filifera are characterized by the possession of very small, all but rod-shaped nematocysts.

Two distinct kinds of stinging capsules occur in the ectodermal tissues of *Myriothela*. Besides the typical oviform ones of the Capitata, there are also present narrowly oval or nearly cylindrical, rather large nematocysts. These dimorphically developed nematocysts of the Myriothelidæ bear a strong resemblance to the stinging capsules of the Milleporidæ which Broch includes in the Sectio Capitata of the Athecate Hydroids.

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* For Numbers I and II see RECORDS OF THE AUSTRALIAN MUSEUM, Vol. xvi, No. 7, 1928, p. 305, and Vol. xvii, No. 5, 1929, p. 244.

1 Broch.—"Hydroida." Danish Ingolf-Expedition, v, 6, 1916.

HYDRANTH.

The hydranth of *Myriothela harrisoni* consists of an isolated attached polyp, divisible into three distinct regions: (1) a slender cylindrical distal portion bearing the tentacles; (2) a swollen, conical middle region bearing the blastostyles, and (3) a proximal hydrorhiza invested by a clear chestnut brown perisarc.

BODY-WALL.

Ectoderm.—In the body-wall of the hydranth (Plate III, fig. 1) the ectoderm is stratified, and varies in appearance and thickness in the different regions of the polyp. Towards the anterior end of the tentacle-bearing zone, the stratified ectoderm (Plate I, figs. 1, 2) consists of an outer part with cells rich in contents and nuclei and an inner lightly-staining hyaline portion. In this region the ectoderm attains a thickness of 15 μ, and carries a number of large oviform nematocysts in its outer part, and a few rather large, nearly cylindrical nematocysts near the bases of the tentacles.

In the middle and posterior regions of the tentacle-bearing zone, the ectoderm (Plate II, Plate III, fig. 1) still retains its division into an outer deeply-staining part and an inner hyaline portion, but the nematocysts are much more numerous than in the anterior region of the hydranth. The two distinct kinds of stinging capsules, typical oviform nematocysts and nearly cylindrical ones, are present in about equal numbers in the ectoderm which now measures 33 μ in thickness.

The ectoderm reaches its greatest thickness of 36 μ in the blastostyle-bearing zone of the hydranth, and presents a distinctly changed appearance since the cells of the inner portion are no longer hyaline, but contain deeply-staining cytoplasm and nuclei. The large oviform stinging capsules are considerably reduced in number, but the nearly cylindrical, rather large nematocysts are widely distributed through the ectoderm of this region.

Supporting lamella.—Throughout the whole extent of the tentacle-bearing zone of the hydranth, the supporting lamella (Pl. III, fig. 1, S.L.) forms a thin but well-defined layer having a uniform thickness of 2 μ. From its outer surface arises a series of very closely placed thin, either simple or branched, secondary lamellæ which stretch out through the whole of the hyaline portion of the ectoderm (Pl. III, fig. 1, Sec. L.). On each side of these secondary lamellæ is attached a layer of well-developed longitudinal muscle fibres (Pl. III, fig. 1, M.F.).

In the blastostyle-bearing region of the hydranth, the supporting lamella increases in thickness, varying from 3 to 4 μ, and gives off rather stout, well-spaced secondary lamellæ at irregular intervals. Attached to the outer surface of the supporting lamella and to each side of these secondary lamellæ are the longitudinal muscle fibres, but they are not so well developed as those in the tentacle-bearing zone. The secondary lamellæ usually remain simple, but occasionally branched ones may be observed giving attachment to a few weakly-developed muscle fibres.

Endoderm.—The endoderm of the body-wall in the tentacular region of the hydranth exhibits a very remarkable differentiation into a distal goblet cell zone and a middle and proximal zone which is characterized by the presence of numerous gland cells and large vacuolate cells. It is impossible, however, to define the exact limitations of these zones owing to the extreme extensibility of this portion of the polyp. The endoderm consists of large-celled tissue and on its inner side is produced into a series of folds which lie close together and

elongated in the direction of the long axis of the body. These folds, forming the villi, project into the body-cavity and vary very much in length in the different divisions of the tentacle-bearing zone of the hydranth. They are longest in the lower portion of this region, where they form filiform structures, and measure 130 to 180 μ from base to apex.

Towards the distal extremity of the hydranth, the villi are considerably reduced, and the endoderm is thrown up into a series of low conical folds which are composed of goblet cells lying wedged between the apices of the palisade-like cells where they abut on the body-cavity (Pl. I, figs. 1, 2). This division of the endoderm constitutes the goblet cell zone which, in the fixed specimen, embraces the anterior one-third of the tentacle-bearing region of the hydranth. Each goblet cell is vase-shaped and consists of a lightly-staining expanded part whose contents are turbid from the presence of ill-defined granular masses. The expanded portion of the vase is continued downwards into a tail which contains a small nucleus embedded in deeply-staining granular cytoplasm. The large coarse granules of the basal portion stain very deeply with Ehrlich's hæmatoxylin.

An examination of a villus from the goblet cell zone (Pl. I, figs. 1, 2) shows that this low conical structure consists of strikingly characteristic palisade-like cells which are remarkably high and of uniform diameter throughout their length. Each has a very scanty and lightly-staining cytoplasm which surrounds a large irregular vacuole occupying the bulk of the cell. Two nuclei are sometimes present, and may be either close together about the middle of the cell, or one at either end. The goblet cells are wedged between the apices of these palisade-like cells along each side of the villus. The apical cells which Hardy[2] found so characteristic of the villi in the goblet cell zone do not become differentiated in *M. harrisoni* in the distal region of the hydranth, but develop at the apices of the villi in the gland cell zone.

In the middle and proximal divisions of the tentacular region, the endoderm assumes a different character (Pl. II). The goblet cells disappear and the palisade cells gradually pass into a shorter and broader type with only one nucleus. The endodermal folds form thin, remarkably high villi which reach out into the body-cavity. As a general rule they are quite separate from one another, but occasionally two villi may become closely adpressed near their apices. Each villus, with the exception of the broader basal portion, consists throughout its length of two layers of cells which are separated from each other by a thin secondary lamella given off from the inner surface of the supporting lamella. At the apex of each villus is a group of apical cells. In these the cytoplasm is abundant and stains deeply, thus offering a marked contrast to the other cells of the villus which Hardy calls the vacuolate cells. These possess a large vacuole surrounded by scanty cytoplasm with only a single nucleus and a few scattered pigmented spheres. Wedged between the outer margins of these vacuolate cells are other and smaller darkly-staining cells which constitute the gland cells and occupy a similar position to the goblet cells in the villi of the goblet cell zone. The gland cells are very widely distributed through the endoderm, but they occur in greatest numbers on the sides of the villi especially in the proximal division of the tentacle-bearing zone. Occasionally one or two of these gland cells may occur at the apex of a villus.

[2] Hardy.—*Quart. Journ. Micro. Sci.* (n.s.), xxxii, 1891.

In the blastostyle-bearing zone of the hydranth the endoderm is to a certain extent different from that already described. The villi here reach their greatest development and almost completely obliterate the body-cavity. The apical cells of the villi change their characters and become more and more akin to the vacuolate cells. These are densely loaded with stored nutritive spheres, so that they present a very different appearance to the vacuolate cells in the villi of the tentacular region. Wedged between the outer margins of these vacuolate cells are the smaller darkly-staining gland cells. These also occur among the endodermal cells at the bases of the villi. The endoderm of the body-wall from which the villi arise, and which in the tentacle-bearing region is composed of cells in no wise distinguishable from those lining the villi, changes its character in the blastostyle-bearing region. There it is composed of long columnar cells, each with a single large nucleus and lightly-staining cytoplasm free from vacuoles.

In *M. harrisoni*, the epithelium lining the gastric cavity is thus clearly divisible into different regions capable of performing different functions according to their constitution and position in the body-wall of the hydranth. These regions are (1) a distal region characterized by the presence of numerous goblet cells, (2) a middle region characterized by the presence of numerous gland cells and large vacuolate cells, and (3) a proximal region characterized by the presence of vacuolate cells usually loaded to the full with stored nutritive material in the form of nutritive spheres.

TENTACLES.

The distal portion of the hydranth bears upwards of six hundred capitate tentacles, densely crowded and imbricating distally, but becoming sparser proximally, the proximal millimetre carrying only about a dozen small tentacles. The head of the tentacle is spheroidal, the long axis continuous with that of the peduncle. A few of the tentacles have confluent patches of pinkish-purple spots upon the distal portion of the capitulum. Each tentacle is a hollow structure with a narrow lumen extending through the stalk. This cavity, however, is limited basally by a partition of unbroken supporting lamella and consequently is completely cut off from the gastric cavity of the polyp. The tentacles are remarkable for the extraordinary development of the supporting lamella in the capitulum where it is produced into a fibrillar structure of radially arranged fibres which stretch out to the ectoderm and form the main mass of the apex of the tentacle.

The stalk of the tentacle (Pl. III, fig. 2) consists of a single layer of ectoderm and a large-celled endoderm which contains a narrow lumen. The supporting lamella is thin; on its outer side is attached a layer of fine longitudinal muscle fibres. In the capitulum of the tentacle (Pl. III, fig. 3) the ectoderm remains simple, thus offering a marked contrast to the stratified condition of the ectoderm in the swollen head of a tentacle from the hydranth of *M. australis*. The supporting lamella increases in thickness and gives rise to a series of radially arranged, coarse threads which stretch out to the ectoderm and form a fibrillar structure of unique appearance in the apex of the tentacle. These threads or fibres are very distinctly marked off from the ectoderm and constitute one of the most distinctive features of the Myriothelidæ. They show no trace of cellular structure and seem to function as a strong supporting cushion in the distal portion of the tentacle which is thus kept in an expanded state even when the rest of the tentacle is contracted. These peculiar fibrillar structures have no counterpart among the

rest of the Hydrozoa and indicate the highly specialized nature of the tentacles in the Myriothelidæ in which the hollow condition of these bodies cannot be regarded as a primitive one but must be considered as a secondary phenomenon.

The endoderm in the apex of the tentacle consists of a single layer of cells which line the upper part of a circular cavity situated in the lower portion of the swollen capitulum. These cells assume a rather different character to the endoderm cells in the stalk of the tentacle since they are very much smaller and more cytoplasmic with deeply-staining nuclei. The floor of this cavity communicates by a narrow aperture with the lumen in the axial part of the tentacle-stalk. The large-celled endoderm of the stalk, however, is completely cut off from the endodermal cells in the body-wall of the hydranth by a partition of unbroken supporting lamella.

The capitulum of the tentacle is richly supplied with nematocysts which are of two kinds: (1) large oviform nematocysts, and (2) nearly cylindrical, rather large nematocysts. A few scattered stinging capsules, similar to those in the capitulum, also occur in the ectoderm of the stem and at the bases of the tentacles.

BLASTOSTYLES.

In *Myriothela harrisoni*, the blastostyle-bearing region of the hydranth is conical in shape with the base and apex practically free from blastostyles. These are borne on the middle zone in such numbers as to hide the surface. The fully-developed blastostyle consists of an irregularly lobed base with a narrow, cylindrical, distal portion continued into a single terminal tentacle generally resembling those of the tentacle-bearing region of the hydranth, but flatter distally and of larger size. The lobes at the base of the blastostyle represent developing gonophores. The mature gonophores are borne distally, and appear terminal in position, having grown so large as to push the single tentacle to one side. The blastostyle has no mouth, but contains an extensive cavity communicating with the general body-cavity of the hydranth.

BODY-WALL.

Ectoderm.—The body-wall of the blastostyle, like that of the hydranth, consists of a stratified ectoderm abundantly provided with large oviform nematocysts, and rather large, nearly cylindrical ones in about equal numbers. In the distal part of the blastostyle the ectoderm is composed of long columnar cells, tapering at their lower end, and filled with a granular and turbid cytoplasm which stains very lightly with hæmatoxylin. The ectoderm of the proximal part differs somewhat from that just described since the columnar cells are replaced by shorter and broader ones and the cell boundaries are frequently very indistinct. The same type of nucleus is found throughout the whole ectoderm. It is characterized by the presence of a distinct nucleolus linked by scattered threads with irregular patches of chromatin on their course to the deeply-staining nuclear membrane.

Supporting lamella.—The supporting lamella varies from 3 to 4 μ in thickness, and gives off rather stout, well-spaced secondary lamellæ at irregular intervals. Attached to the outer surface of the supporting lamella and to each side of these secondary lamellæ are the longitudinal muscle fibres which are not so strongly developed as those in the body-wall of the hydranth.

Endoderm.—The endoderm in the proximal region of the blastostyle is composed of long columnar cells, each with a single nucleus and lightly-staining cytoplasm free from vacuoles. Gland cells lie scattered in the endoderm of this region and sometimes occur in limited numbers where the endoderm of the blastostyle merges with that of the body-wall of the hydranth. Towards the distal extremity of the blastostyle, the endoderm changes its character and forms a series of very high villi which reach out into the body-cavity. Each villus, with the exception of the broader basal portion, consists throughout its length of two layers of cells which are separated from each other by a thin secondary lamella given off from the inner surface of the supporting lamella. These cells possess a large vacuole surrounded by scanty cytoplasm with only a single nucleus. They are densely loaded with stored nutritive spheres, and consequently present a very different appearance to the rest of the endoderm in the blastostyle. The endodermal cells of the body-wall, from which the villi arise, retain their columnar character and remain free from vacuoles and nutritive spheres.

TENTACLE.

The single terminal tentacle at the distal extremity of the blastostyle differs in several important points from the tentacles of the hydranth, being of larger size and provided with a trumpet-shaped capitulum instead of the typical spheroidal head. In the apex of this tentacle, the supporting lamella remains comparatively thin, and is not produced into the extraordinary fibrillar structure which forms such a characteristic feature in the capitulum of the tentacles from the tentacle-bearing region of the hydranth. The tentacle is a hollow structure with a narrow lumen extending through the stalk. This cavity, however, is limited basally by a partition of unbroken mesoglœa and consequently is completely cut off from the body-cavity of the blastostyle. I have previously directed attention to the existence of a similar condition in the blastostylic tentacles of *M. australis*. A comparison of my drawing (Pl. XXXIV, fig. 2)[3] with the description of the tentacle from the blastostyle of *M. harrisoni* immediately reveals the remarkable similarity in form displayed by these structures in both species.

The stalk of the tentacle consists of a single layer of ectoderm and a large-celled endoderm which contains a very narrow lumen. The supporting lamella is thin. In the capitulum, which is trumpet-shaped, the ectoderm is composed of remarkably high columnar cells with granular cytoplasm and very indefinite cell-walls. The supporting lamella increases in thickness but still remains comparatively thin. From its outer surface arises a series of very short, fine threads or fibres which stretch out to the ectoderm. The endoderm in the apex of the tentacle consists of a single layer of cubical cells which line the upper part of the circular cavity situated in the lower portion of the trumpet-shaped capitulum. These cubical cells may be readily distinguished from the rest of the endoderm not only by their characteristic shape but also by their granular cytoplasm and slightly larger nuclei. The floor of the cavity communicates by a narrow aperture with the lumen in the axial part of the tentacle-stalk. The large-celled endoderm at the base of the stalk is completely cut off from the endodermal cells in the body-wall of the blastostyle by an unbroken partition of supporting lamella.

[3] See Part I, REC. AUSTR. MUS., xvi, 7, 1928.

The capitulum of the tentacle is richly supplied with nematocysts. These are almost entirely represented by the rather large, nearly cylindrical type of stinging capsule, and are arranged in a very characteristic manner in the outer hyaline portion of the ectoderm with their long axes set at right angles to the surface. A few scattered ones of the same type lie in various directions in the deeper parts of the ectoderm close to the supporting lamella. Near the base of the tentacle, the ectoderm may contain several oviform, as well as cylindrical, nematocysts but this region is usually free from stinging capsules, although they occur in large numbers in the adjacent ectoderm of the blastostyle.

Gonophores.

Like *Myriothela australis*, *M. harrisoni* is a diœcious species, all the gonophores on a blastostyle being of the same sex, and throughout any one individual the sex of the gonophore is uniform. The mature gonophores are sub-spherical in shape, somewhat flattened distally, and are either sessile or very shortly pedunculate. They exhibit no definite arrangement on the blastostyle, except that the mature ones are borne distally and appear terminal in position, having grown so large as to push the single tentacle to one side.

In the male, the blastostyle bears two or three ripe gonophores, up to 450 μ in diameter, and three or four in process of development. The only female individual was cut into sections before the diœcious habit was discovered and entire blastostyles are not available for comparison. The ripe female gonophores have a diameter almost twice that of the male.

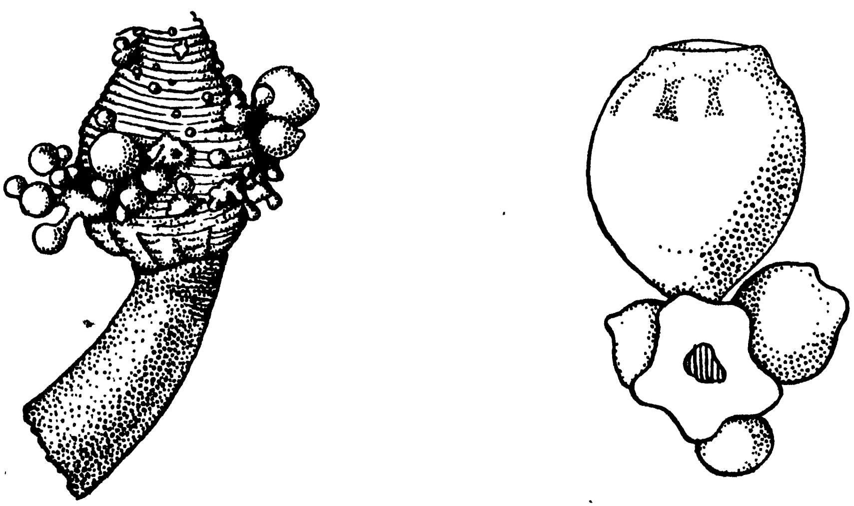

FIGURE 1.
Myriothela harrisoni, Briggs. Blastostyles and gonophores.

Both the male and the female gonophores have an apical opening representing the velar aperture. This feature is unique among the species of *Myriothela*, except *M. australis* where a similar condition exists in the gonophores of both

sexes. The remarkable structures to which Allman[4] gave the name of "claspers" in his description of *M. cocksi* do not occur in *M. harrisoni*.

In the mature gonophores of both sexes, the ectoderm at the flattened distal extremity is armed with scattered nematocysts of the cylindrical variety with here and there an occasional large oviform stinging capsule. On the whole the gonophores of *M. harrisoni* are singularly devoid of nematocysts, and in this character alone they exhibit a considerable variance from the northern species, since Broch in his diagnosis of the Family Myriothelidæ specially stresses the frequent occurrence of stinging capsules in the ectoderm of the gonophores.

NEMATOCYSTS.

Kuhn's classification[5] of the Athecate Hydroids into two principal groups of Filifera and Capitata, based on the presence of filiform or claviform tentacles, cannot be strictly maintained since the distinction is by no means a constant one. This is clearly shown in the case of the Pennaridæ where filiform tentacles occur together with claviform ones. Broch, however, has recognized that Kuhn's grouping may be retained if we accept the form of the nematocysts as a criterion of classification, and regard the Athecate Hydroids as falling into the two principal groups, corresponding to the Capitata and Filifera, according to the structure of the stinging capsules. In all the Capitata there are large oviform or almost wholly spherical nematocysts. These are always accumulated on the tips of the claviform tentacles, while in those species possessing filiform tentacles they are more equably distributed through the ectoderm of the tentacles. Moreover, these large nematocysts are also widely distributed throughout the ectoderm of the polyp especially in such forms as *Monocoryne* and *Myriothela*.

The Filifera are distinguished by a quite different type of nematocyst. The predominant form is a very small, all but rod-shaped stinging capsule which occurs in large numbers in the ectoderm of the tentacles. Here they are generally arranged in definite belts which impart to the tentacles a transversely striped appearance.

In *Myriothela* the nematocysts have developed dimorphically; besides the typical large oviform ones (Pl. III, fig. 4) there are also present narrowly oval or nearly cylindrical stinging capsules which are of frequent occurrence in the ectoderm of the polyp but more especially in the capitulum of the tentacles at the distal extremity of the blastostyle (Pl. III, fig. 5).

The large oviform nematocysts of *M. harrisoni* measure 10 to 12 μ in length and 8 to 9 μ in breadth. Each contains a comparatively stout thread which appears to be spirally coiled (Pl. III, fig. 4). This type of nematocyst is widely distributed through the ectoderm of the hydranth and blastostyle, and also occurs in fairly large numbers among the ectoderm cells in the capitulum of the tentacles borne on the hydranth. The nearly cylindrical stinging cells measure 15 to 21 μ in length and 6 to 9 μ in breadth. They occur throughout the ectoderm of the polyp, but are found in largest numbers in the capitulum of the tentacle at the distal extremity of the blastostyle (Pl. III, fig. 5). In this position they are arranged in a closely packed layer which lies in the outer, hyaline portion of the ectoderm. The long axes of the nematocysts are set at right angles to the

[4] Allman.—*Phil. Trans.*, clxv, 1875.

[5] Kuhn.—*Ergebn. und Fortschr. der Zool.*, iv, 1913.

surface of the capitulum, and as a result of this arrangement the stinging capsules are disposed in a definite radial manner.

The oviform nematocysts of *M. australis* are slightly smaller than those of *M. harrisoni*, since they measure 9 to 10 μ in length and 5 to 6 μ in breadth. The nearly cylindrical stinging capsules are considerably smaller, measuring 9 to 10 μ in length and 3 μ in breadth. These two types of nematocyst, oviform and cylindrical, although their dimensions are not so large, are identical with the forms which I have described in the tentacles and the nematocyst ring of the crawling medusa *Cnidonema haswelli*[6] from Port Jackson, New South Wales.

Billard's work[7] on the biology and regeneration of *Myriothela cocksi* from L'île Ti-sao-son at Roscoff enabled him to observe the function of the nematocysts in living specimens during feeding experiments. His examination revealed the presence of "deux catégories de nématocystes, ou cnidocytes: les uns sont adhésifs, les autres sont urticants." The former exist in two sizes; there are small ones which reach a length of 12 μ, and larger ones which are double this measurement. Billard claims that these two types of adhesive nematocysts are identical with those he observed in *Clava squamata* and *Hydractinia echinata*, as well as in the medusa of *Cladonema radiatum*. Their function is to capture and hold the prey. The urticating nematocysts, according to Billard's account, are provided with a filament which penetrates the tissues of the prey and by the injection of a poison causes paralysis followed by death.

The distinction of the oviform or adhesive nematocysts into small and large types such as Billard describes, is not so well marked in the Australian species of *Myriothela*; in fact the adhesive stinging capsules are fairly uniform in size, the smallest measuring 10 μ and the largest 12 μ in length for *M. harrisoni*, while in *M. australis* the difference in size is even less apparent since the measurement of the long axis varies only from 9 to 10 μ in length.

SUMMARY.

1. The salient features in the histology of *Myriothela harrisoni*, Briggs, are described and figured.
2. The ectoderm of the hydranth is stratified; the supporting lamella is thin and from its outer surface arises a series of either simple or branched secondary lamellæ; the endoderm consists of (*a*) a distal region rich in goblet cells, (*b*) a middle region characterized by the presence of gland cells and vacuolate cells, and (*c*) a proximal region of vacuolate cells loaded with stored nutritive material.
3. The tentacles of the hydranth are remarkable for the extraordinary development of the supporting lamella in the capitulum where it is produced into a fibrillar structure of radially arranged fibres which form the main mass in the apex of the tentacle.
4. The blastostyles are borne on the middle zone of the hydranth in such numbers as to completely hide the surface. Each consists of an irregularly lobed base with a narrow, cylindrical, distal portion continued into a single terminal tentacle.

[6] Briggs.—Rec. Austr. Mus., xiii, 3, 1920.
[7] Billard.—*Bull. Soc. Zool. de France*, xlvi, 1921.

5. **The species is diœçious; the mature gonophores are sub-spherical in shape, somewhat flattened distally, and are either sessile or shortly pedunculate.**
6. **Both the male and female gonophores have an apical opening representing the velar aperture.**
7. **The nematocysts are of two kinds: (1) large oviform nematocysts, their length being 10 to 12 μ and their breadth 8 to 9 μ; and (2) nearly cylindrical nematocysts which measure 15 to 21 μ in length and 6 to 9 μ in breadth.**

EXPLANATIONS OF PLATES.

PLATE I.

Myriothela harrisoni, Briggs.

Fig. 1.—Transverse section through the distal end of the tentacular region of the hydranth. The endoderm is produced into a series of low, conical villi. This division of the endoderm constitutes the goblet cell zone.

Fig. 2.—Transverse section through the body-wall towards the distal extremity of the tentacular region of the hydranth. The villi are composed of goblet cells lying wedged between the apices of the palisade cells where they abut on the body-cavity.

PLATE II.

Myriothela harrisoni, Briggs.

Transverse section through the body-wall in the middle division of the tentacular region of the hydranth. The endodermal folds form thin, remarkably high villi which reach out into the body-cavity.

PLATE III.

Myriothela harrisoni, Briggs.

Fig. 1.—Transverse section through the ectoderm and supporting lamella of the body-wall in the tentacular region of the hydranth. From the outer surface of the supporting lamella arises a series of very closely placed thin, either simple or branched, secondary lamellæ. On each side of these secondary lamellæ is attached a layer of well-developed longitudinal muscle fibres. *Ect.*, ectoderm; *M.F.*, muscle fibres; *Sec. L.*, secondary lamella; *S.L.*, supporting lamella.

Fig. 2.—Transverse section through the stalk of a tentacle from the tentacle-bearing zone of the hydranth. The longitudinal muscle fibres are seen on the outer side of the supporting lamella.

Fig. 3.—Transverse section through the capitulum of a tentacle from the tentacle-bearing zone of the hydranth, showing the great thickness attained by the supporting lamella.

Fig. 4.—A large oviform nematocyst from the ectoderm of the hydranth.

Fig. 5.—One of the cylindrical nematocysts from the capitulum of the tentacle at the distal extremity of the blastostyle.

ON SOME NEW AND LITTLE-KNOWN AUSTRALIAN ASTEROIDS.

By

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(Plates iv-viii.)

Every species referred to herein has been seen by Dr. H. L. Clark, of the Museum of Comparative Zoölogy, Cambridge, Massachusetts, United States of America, to whom I wish to express my sincere thanks for kind advice and assistance. Giving me his tentative opinion in each case where his advice was sought he allowed me every freedom in action, and so greatly do I value his opinion that, in most cases, I have adopted his suggestions after due consideration. As Dr. Clark's time was short when he visited the Australian Museum in November of 1929, he did not have an opportunity to investigate each species fully, so in fairness no blame for error in judgment, should there be any, can be ascribed to him.

Family GONIASTERIDÆ Forbes 1841 (emended).

Sub-family GONIASTERINÆ Verrill 1899 (extended).

Pseudogoniodiscaster gen. nov.

Diagnosis.—Rays tapering and blunt, moderately wide. Abactinal plates distinct, coarsely granulated, separated, except for faint line-like connecting plates which give the entire abactinal surface a reticulated appearance, by large papular areas. Papular areas with one or two minute pincers. Abactinal interradial plates enlarged; third from superomarginals the largest. Five large primary radial tubercles on disc forming a pentagon. Small bivalved pedicellariæ on infero- and superomarginal plates. Marginal plates of both series increasing in width from interradius to apex of ray, noticeably so in inferomarginals. Third superomarginal from apex of ray is the widest. The corresponding plate below in the inferomarginal series is slightly narrower, but is either the widest or as wide as any other in its series. Superomarginals and abactinals in some cases bear fairly large tubercles. Tubercles most numerous on superomarginals in interbrachial arc. Actinal surface smoothly granulated. Plates fairly well defined and provided with very large bivalved pedicellariæ as seen in *Hippasteria* and *Anthenea*. Adambulacral armature in three series. Long pincer-like pedicellariæ between spines of adambulacral armature.

Type.—*Pseudogoniodiscaster wardi* sp. nov.

Affinities.—Many characters possessed by the type species of this genus suggest alliance with both *Goniodiscaster* and *Anthenea*, but neither of these genera could claim *Pseudogoniodiscaster wardi* sp. nov. as a representative. *Goniodiscaster* possesses more characters in common with *Pseudogoniodiscaster* than *Anthenea* or any other known genus of the family Goniasteridæ, and they are as follows: a pentagon of five tubercles on disc; marginal plates of both series

regularly increasing in size from interradius to apex of ray; the median series of abactinal interradial plates enlarged; bivalved pedicellariæ on both surfaces. Small pincer-like pedicellariæ on papular areas.

The characters possessed by *Pseudogoniodiscaster* distinguishing it from *Goniodiscaster* are as follows: Outlines of abactinal and actinal intermediate plates distinct, most decidedly so on the former mentioned area; papular areas with many papular pores, always more than five to an area, even on ends of rays; actinal surface with very large bivalved pedicellariæ. Not all plates are closely granulated, but only those of marginal series, and even on these the granules are smooth.

The salient feature separating *Pseudogoniodiscaster* from *Anthenea* is the former's lack of a thick skin overlying and obscuring the outlines of the plates. The lack of coarse granules on the actinal plates and marginals and the presence of two types of pedicellariæ instead of only one, the widened bivalve type, further distinguish *Pseudogoniodiscaster* from the genera of the sub-family Antheneinæ.

Pseudogoniodiscaster wardi sp. nov.

(Pl. iv, figs. 1-2; Pl. v, figs. 1-3.)

Description.—R. = 77 mm., r. = 37 mm., R. = 2·08 r., Br. ray at base (between interradials) 42 mm. Rays five, flattened both actinally and abactinally; broad and bluntly rounded at tips. Disc large and raised. Interbrachial arcs rounded. The broad rays taper from base towards apex. The abactinal skeleton is made up of a number of plates all more or less uniform in size except those of the median radial and median interradial series, which are, on the whole, larger than any other plates on the abactinal surface. All, except most of those in the median interradial series, are connected by faint line-like connecting plates and the plates closest to the superomarginals are connected to these latter in a similar manner. All the plates on the abactinal surface are covered by fairly fine granules. Besides granules, some plates bear well developed tubercles, which are conical and bluntly pointed. All plates on the abactinal surface are provided with from one to six bivalved pedicellariæ which are situated at random between the granules. All abactinal plates are arranged in regular order. Between the interradial furrows and, omitting the plates of that series, there are seven series of plates. These are made up of the median radial series and three lateral series on each side. The median radial or carinal series contains thirteen plates, which are slightly larger than those in the series alongside. The median radial series in each case is interrupted near the top of the disc by one of five large radial tubercles which collectively form a pentagon. These radial tubercles are very large. They are granulated basally and entirely bald on their free extremity. They are round and bluntly pointed. The median radial series of abactinal plates terminate near the tip of the ray between the third and fourth superomarginal. The series next to the median radial contains ten plates and ends towards the tip of the ray between the sixth and seventh superomarginal. The next lateral series in turn contains three or four plates, while the last series contains only two plates. The interradial furrow is conspicuous. Its plates are four in number; the third from the margin is not only the largest of the

series, but is also the largest on the abactinal surface. The madreporite is large and measures 5 mm. by 6 mm. It is situated at the inner extremity of the interradial furrow and between two of the five tubercles which form a pentagon on the disc.

The abactinal papular areas are sunken below the level of the abactinal plates. They are large and scattered with some regularity between the plates. The papular areas vary in size and shape; sometimes they may be as large in extent as most abactinal plates or, on the other hand, they may be very small. The presence of such papular areas gives the abactinal surface a peculiar mottled appearance. The number of pores in the papular areas ranges from eight to thirty-eight. Minute pincer-like pedicellariæ occur in ones or twos on the papular areas. The papular areas are granulated.

The marginal plates of both series increase regularly in size from the interradius to the apex of the ray. The third superomarginal plate from the apex of the ray is swollen, and is the widest in either series. The plate corresponding to the fourth superomarginal in the inferomarginal series is slightly smaller, though it may be as wide as or even wider than any other plate in its series. The superomarginals are covered by very fine and closely packed granules which give them a smooth appearance. Tubercles varying considerably in size from enlarged granules to conspicuous and rounded bosses occur at random along the superomarginal series. The largest tubercles usually occur on plates in the vicinity of the interbrachial arc. No tubercles or even enlarged granules occur on plates in the inferomarginal series. Small bivalved pedicellariæ occur at random among the granules of both marginal series. These pedicellariæ, however, are, for the most part, confined to plates of the interbrachial arc. Corresponding plates of both marginal series are, in the main, of equal width, but, besides the difference described as occurring in the vicinity of the tips of the rays, there is a difference seen in the narrowness of inferomarginals in the interradius when compared with the superomarginals in that region. Everywhere except near the tips of the rays the inferomarginals project outward beyond the superomarginals, so that they are visible on a vertical view.

Actinal plates clearly defined, decreasing in size as they approach the margin. Plates near margins smoother and more closely granulated than those further in. Nearly all plates, except those near margins, bear very long bivalved pedicellariæ similar to those seen in *Anthenea* and *Hippasteria*. The largest measures 4·5 mm. long and the smallest 2 mm. In isolated cases the pedicellariæ are branched or distorted, thus becoming tri-radiate.

The armature of the adambulacral plates consists of a furrow series of six to seven (usually six) spinelets which are stout and flat-sided. Their length is evenly graded so as to form a fan-like crescent. The middle spinelets are both the longest and thickest. Most are widest at tip, but usually the two smallest spinelets on the lateral extremities of the comb are flattened and sharply pointed. Immediately behind the furrow series is a second series of three to four, usually three, extremely broad and stubby spinelets. The middle spinelet is usually roundly rectangular and is widest at the tip. The lateral spinelets of this second series are a little shorter, though flat-sided like the central spinelet. On the outer margin of the adambulacral plate lies a series of spine-

like granules which are both short and stout. They are arranged in twos or threes, are flat-sided, and in section would appear triangular, rectangular, or diamond-shaped.

Situated near the innermost side of most adambulacral plates, especially in the free half of the ray, lies a pedicellaria which varies both in size and proportion. In some cases these pedicellariæ are higher than wide, and appear like stout spines split longitudinally in half, while in other cases, which are not so common, the pedicellariæ are wider than high and appear like very much raised bivalved pedicellariæ. Sometimes these pedicellariæ take the place of spines in either the second or third adambulacral series.

Colour.—Mr. Melbourne Ward, for whom the species is named, states that in life the colour of the specimen was a dark green, abactinally resembling the colour of the weed on which the specimen was found.

Holotype.—The holotype is the only known specimen and is housed in the Australian Museum, Sydney.

Locality.—Among weed, Rat Island, between Curtis Island and Facing Island, Port Curtis, Queensland; collected by Messrs. M. Ward and W. Boardman, July, 1929.

Ferdina ocellata H. L. Clark.

(Pl. vi, figs. 1-2.)

Ferdina ocellata H. L. Clark, The Echinoderm Fauna of Torres Strait, 1921, p. 60, Pl. vi, fig. 5; Pl. xxxi, figs. 1-2.

There are two specimens in the Australian Museum collection. One is undoubtedly the species described by Dr. Clark, while the other presents characters which make an understanding of the species and its near allies rather difficult. The specimen most like Dr. Clark's species comes from Mer, Murray Islands, the type locality, and was collected there in 1907 by the late Messrs. Hedley and McCulloch. The other specimen was collected near the edge of a coral reef at North-West Islet, Capricorn Group, Queensland. Specimens of the species are by no means common either at Mer or North-West Islet, and this fact renders the collection of a series for comparison very difficult.

The North-West Islet specimen, despite its varying characters. cannot be associated with any other species of the genus. It agrees with the characters set out by Clark (*loc. cit.*) to distinguish his species from closely allied species of the genus, so that its nearest known relative is *ocellata*. Until further specimens are obtained it will not be possible to ascertain the limits of Clark's species or determine whether the specimen from North-West Islet is a variable form of *ocellata* or a totally distinct species.

The measurements of the two specimens before me are:

Mer, Murray Islands specimen—R. = 42·5 mm., r. = 12 mm., R. = 3·5 r., Br. ray at base (between the first and second superomarginals) 11·25 mm., R. = 3·6 br.

North-West Islet specimen—R. = 42 mm., r. = 12 mm., R. = 3·5 r., Br. ray at base (between first and second superomarginals) 12 mm., R. = 3·5 br.

It is of interest and importance to note that Clark's holotype and the two present specimens are all about the same size.

Following is a review of the characters possessed by the North-West Islet specimen and differing from those set out by Clark (*loc. cit.*) for his specimen and also from those of the specimen before me from Mer, Murray Islands.

Superomarginal plates 18 to 20 instead of 13 to 15. Superomarginal series most irregularly arranged and in no way alternately arranged as described by Clark and exhibited by the specimen from Mer before me. The first superomarginal of each series not enlarged and its adjoining fellow, although closely placed, does not assist in "forming a conspicuous area on the interradial margin of disk" as described by Clark. Superomarginals much smaller than indicated by Clark or shown on the present specimen from Mer. There are 18 to 24 inferomarginals as against 16 to 18 on Clark's specimen and the other one from Mer. Inferomarginals not regularly placed. Abactinal plates, on the whole, larger than those seen on the present specimen from Mer. Bare plates scarce on abactinal surface; none confined to distal half of each ray or arranged either as depicted by Clark or as seen on the specimen from Mer.

Colour.—Colour in life not noted. Colour when dry after preservation in alcohol is:

Mer, Murray Islands, specimen, dark cream abactinally, paler actinally. Deep orange-brown along abactinal interradial furrows.

North-West Islet specimen, pale biscuit yellow actinally and abactinally. Bright orange in the vicinity of interradial areas.

Localities.—Mer, Murray Islands, Torres Strait; collected by the late Messrs. C. Hedley and A. R. McCulloch, 1907. Near edge of coral reef between tide marks, North-West Islet, Capricorn Group, Queensland; collected by Messrs. M. Ward and W. Boardman, 1929.

Ophidiaster confertus H. L. Clark.

Ophidiaster germani Etheridge Jun (*non* Perrier), Austr. Mus. Memoir, ii, 1, 1889, p. 39.

Ophidiaster germani H. L. Clark (*non* Perrier), Austr. Mus. Memoir, iv, 1909, pp. 519, 520 and 529.

Ophidiaster confertus Coleman, MS.

Ophidiaster confertus H. L. Clark, Biological Reports, "Endeavour," iv, 1916, p. 53, Pl. xv, figs. 1-2.

Ophidiaster confertus H. L. Clark, Echinoderm Fauna of Torres Strait, 1921, p 83.

As the history of this species has become a little involved it has been considered necessary to review the literature and make it more readily comprehensible. Additional records as to the occurrence of this species are given below.

History.—The first mention of the species was made by Etheridge Jun. (*loc. cit.*) under the name *Ophidiaster germani* Perrier. This wrongly identified specimen is before me and is undoubtedly *Ophidiaster confertus*.

In 1909 Clark (*loc. cit.*) referred to *Ophidiaster confertus* also under the name *Ophidiaster germani*, but made known his doubt as to the validity of his identification. Clark's "Thetis" specimen is also before me labelled in that author's handwriting as *Ophidiaster germani*. There is no doubt that this specimen is, like Etheridge's, *Ophidiaster confertus*.

Coleman evidently realised that *Ophidiaster germani* of Etheridge and Clark was not the species intended by Perrier and applied the manuscript name

Ophidiaster confertus to some specimens in the collection of the Australian Museum. The name was never published by Coleman.

It fell to Clark in 1916 to publish a name for the species, when he used for the purpose some Lord Howe Island specimens sent him by the authorities of the Australian Museum with the "Endeavour" collection of echinoderms.

The last published reference to the species was made by Dr. Clark in 1921 when dealing with his Torres Strait material. In this work he states that the species is as yet known only from Lord Howe Island. It may be well to mention that Dr. Clark[1] considers that *Ophidiaster germani* Perrier is a synonym of *Ophidiaster cribrarius* Lütken. Dr. Clark states that the colour in life of *Ophidiaster confertus* has not been recorded, but Etheridge (*loc. cit.*) states that it is "a dull red colour".

Localities.—Lord Howe Island, South Pacific.

The specimens in the Australian Museum collection are:

2 specimens from Long Reef, Collaroy, on coast about 7 miles north from Port Jackson, New South Wales. Collected by M. Ward, 1927.
R. = 87 mm., R. = 54 mm.

1 specimen from Shellharbour, south coast of New South Wales, between tide marks. Collected by G. McAndrew.
R. = 30 mm.

1 specimen from Little Bay, about 6 miles south of Port Jackson, New South Wales, between tide marks, under stones.
R. = 82 mm.

1 specimen from North-West Islet, Capricorn Group, Queensland. Collected by Messrs. Ward and Boardman, July, 1929.
R. = 115 mm. (ray curled).

Nardoa mamillifera sp. nov.

(Pl. vii, figs. 1-5.)

Description.—One single dry example, R. = 63 mm., r. = 11 mm., br. ray at base (exclusive of tubercles) 14 mm. Judging by the three-rayed abnormal specimen before me it appears that, when normal, the species possesses five rays. The disc is small and slightly elevated. Interbrachial arcs acute. The rays taper slightly, though distinctly, towards their tips and are semi-circular dorsally and flattened ventrally.

The abactinal skeleton is composed of a number of plates which are extremely variable in both size and shape. Moreover, they exhibit no systematic arrangement. The largest plates are in the form of large rounded tubercles as seen in *Nardoa frianti* Koehler.[2] These tubercles are clothed in granules which are quite visible to the naked eye, particularly in the central areas where they are largest. The large abactinal tubercles measure as much as 4 mm. in diameter, but others, which are smaller, are in the vicinity of 2·5 to 3·5 mm. Still smaller tubercles are scattered at random between their bigger fellows and measure between 1·5 to 1·75 mm. across. These smaller tubercles are most numerous

[1] H. L. Clark.—Echinoderm Fauna Torres Strait, 1921, p. 77.

[2] Koehler.—Indian Museum Asteroidea, 1910, p. 158, pl. xvii, figs. 3-4.

in the region of the ray tips. The entire abactinal surface is covered by coarse and spaced granules of varying sizes. Between the granules the papular pores occur either in lines, circles, or in groups of from ten to twelve. The pores are more numerous on the disc than elsewhere. The madreporite is small and somewhat diamond-shaped; 1 mm. wide. It is situated on the side of a medium-sized tubercle on the disc. It lies in the interradius about half way between the centre of the disc and the margin.

The actinal surface is made up of three regular series of plates counting the inferomarginal series. Every plate of the three series is covered by a number of stout well spaced granules, the biggest of which occur in the centre of the plate. Whether big or small, each granule is slightly elongate and straight-sided, thus making a section appear roundly pentagonal or square. The largest elongated spinelet-like granules occur on the adambulacrals. The first series of ventral plates, the adambulacral series, are arranged in a regular order. Most plates in this series are rectangular in shape, slightly ovate, their width being about half their length. They are, for the most part, the smallest plates on the actinal surface. Their greatest number, before they are displaced by the inferomarginals near the tips of the rays, is 37. The lowest number counted is 23. The difference in the number of the adambulacrals is due to the fact that in some series they are both large and small, the biggest sometimes equalling an inferomarginal plate in size. A second series of actinal plates occurs between the adambulacral and the inferomarginal series There are four plates in each of these second series, which commence at the base of the ray. They terminate at either the second or third inferomarginal counting from the basal end. In size the plates of the second ventral series are a little larger than an average adambulacral plate.

The inferomarginal series contains the largest plates on the actinal surface, although some, as indicated above, are only as big as a small adambulacral. The greatest number of plates counted in an inferomarginal series was 35 and the least 25. The largest inferomarginal plate on the specimen measured 2·5 mm. in width Actinal papular pores are fairly numerous and are arranged both in groups and lines between the regular series of plates. The superomarginal plates are in a more or less regular series. They are well spaced in some places, while in others they are placed close together. In size they vary greatly, measuring anything between 4 mm. and 1·75 mm. in width

The armature of the adambulacral plates consists of a furrow series of 4 to 5 (usually 4) stout, flat-sided, long and bluntly pointed spinelets. They are all of approximately the same length. A fifth (or sixth, as the case may be) small and ill-developed, though wide and flattened spinelet, usually occurs on the inner corner of the plate. Each furrow comb is arranged obliquely, with the result that each overlaps its immediate neighbour. Immediately behind the furrow series is a second row of 3 to 4 spinelets, which are, in the main, on a level with those of the furrow series, but differ in being considerably thicker. Like those of the furrow series, the spinelets of the second series are noticeably flat-sided. The central one or pair of this second series is always the thickest. On the outer margin of the plate are 3 to 4 slightly smaller though well-defined spinelets which constitute a third series. These, like the two inner series, are flat-sided and appear like square columns with blunt rounded tips.

Colour.—The colour of this species in life is unknown. After preservation in 75% alcohol and dried the colour is pale biscuit yellow.

Holotype.—The holotype, the only known specimen, is housed in the Australian Museum, Sydney.

Locality.—Mer, Murray Islands, Torres Strait; collected by the late Messrs. C. Hedley and A. R. McCulloch in 1907.

Affinities.—The only known species approaching *Nardoa mamillifera* is *Nardoa frianti* Koehler (*loc. cit.*). *Nardoa mamillifera*, however, can be easily distinguished from Koehler's species by the arrangement of the actinal intermediate plates, which is by far the most distinctive character.

Remarks.—The single specimen before me has, during its life, been deprived of what would seem to be two rays. This, incidentally, is a common occurrence among members of the genus *Nardoa*. The three remaining rays, however, show the species to be quite distinct from any known members of the genus and well worthy of separation. Dr. Clark has informed me that he has never before seen a *Nardoa* with such characters.

Nardoa mamillifera is the fifth species of the genus to be recorded from the Torres Strait region. The other four are *Nardoa pauciforis* von Mart., *N. novæcaledoniæ* Perrier, *N. mollis* de Loriol and *N. rosea* H. L. Clark.

Tamaria fusca Gray.

(Pl. viii, figs. 2, 5.)

Tamaria fusca Gray, Ann. Mag. Nat. Hist , vi, 1841, p. 283.

Tamaria fusca H. L. Clark, The Echinoderm Fauna Torres Strait, 1921, p 89, Pl. xxviii, figs. 1-2 (and synonymy).

A specimen of this species which agrees well with Fisher's[3] notes and figures is before me and forms a new record for the species. Further, its structure shows little or no variation from the characters described and depicted by Fisher, thus proving that, in some cases at least, specimens from widely separated localities can be constant in form.

The present specimen measures: R. = 50 mm., r. = 9 mm., R. = 5·5 r. As the species is said by Clark (*loc. cit.*) to be very variable, figures of the present specimen have been submitted in order to illustrate the similarity between it and Fisher's Philippine specimens. These latter, according to Fisher, "appear to be fairly typical examples of the species".

Locality.—Dredged in 9 fathoms off Lindeman Island, Whitsunday Passage, Queensland, 1929; collected by Mr. Melbourne Ward. (Since this paper was written further specimens have come to hand which affect the status of this specimen. Details will appear in report on Asteroidea of British Great Barrier Reef Exped., 1928-1929.—AUTHOR.)

Tamaria tuberifera (Sladen).

(Pl. iv, fig. 3; Pl. viii, figs. 1, 3, 4.)

Ophidiaster tuberifer Sladen, Voy. "Challenger," Zool., xxx, 1889, p. 404, Pl. lxv, figs. 1-4.

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[3] Fisher.—U.S. Nat. Museum, Bull. 100, 1919, p. 388, pl. 95, figs. 5-5*a*-*c*; pl. 103, fig. 4; pl. 104; fig. 1; pl. 111, figs. 5-6.

Ophidiaster tuberifer Fisher, U.S. Nat. Museum, Bull. 100, 1919, p. 393.

Tamaria tuberifera H. L. Clark, Echinoderm Fauna Torres Strait, 1921, p. 90, Pl. viii, fig. 1.

No hesitation whatever is experienced in referring two specimens before me to this species. As was the case with Fisher's material, only two specimens are present for examination, a large one and a very small one.

The smallest specimen measures: R. = 22 mm., r. = 4 mm., br. ray at base 4 mm. It was dredged off Peak Point, north Queensland, 3-6 fathoms.

Like Fisher's smallest specimen the present small one before me lacks the usual large number of papular pores to an area, there being usually only three to six. Only single pores occur near the tips of the rays.

The adambulacral armature is arranged in three series. Many carinal plates as well as most of the marginals bear the characteristic central tubercle and in all other essential respects it agrees with Sladen's description and figures.

The measurements of the larger specimen are: R. = 66 mm., r. = 11 mm., R. = 6 r., br. ray at base 11 mm. This specimen was dredged in the vicinity of Thursday Island. Semon's specimen (1896) was collected at Thursday Island. The presence of a central tubercle on many of the carinal plates as well as the marginals entirely disposes of the suggestion that only the young of the species bear this character. It is therefore necessary to modify the characters so admirably set out by Clark (*loc. cit.*, p. 88) for the species in the form of a key. The marginal plates of both series are well provided with tubercles, particularly on the free half of the ray.

The papular areas are made up of from 10 to 18 pores, but on the tips of the rays the number of pores is small, usually 3 to 4. The papular areas are characteristically large and well defined.

The spines of the adambulacral armature are in three series and arranged as described by Sladen. The outermost series of spines, which are the largest, grow less in number and are spaced wider apart as they approach the tips of the rays.

Both specimens possess the dark patches of brown on the papular areas and elsewhere as described by Sladen, despite the fact that they have been preserved in alcohol for some months and then dried.

Both specimens possess pedicellariæ, but details in the character of those on one specimen differ from those seen on the other. The larger specimen possesses pedicellariæ with crenulated borders as opposed to the smooth borders inferred by Sladen and described by Fisher (*loc. cit.*). All other characters relating to the pedicellariæ on the larger specimen, are, however, as described and figured by Sladen.

In the smaller specimen the pedicellariæ have smooth borders, thus agreeing with Sladen's and Fisher's remarks.

Fisher's larger specimen is 67 mm. The larger specimen before me is 66 mm. In Fisher's specimen the pedicellariæ have smooth borders. In the larger present specimen the borders are crenulate. It is obvious, then, that the variation is not due to growth, but to individual peculiarity.

Localities.—Dredged in the vicinity of Thursday Island, north Queensland, 1928; collected by Mr. Melbourne Ward (larger specimen). Dredged off Peak Point, north Queensland, 3-6 fathoms, rocky bottom, 1928; collected by Mr. Melbourne Ward (smaller specimen).

EXPLANATIONS OF PLATES.

PLATE IV.

Fig. 1.—***Pseudogoniodiscaster wardi*** gen et sp. nov. **Abactinal view of holotype. (Slightly under natural size)**

Fig. 2.—***Pseudogoniodiscaster wardi*** **gen.** et sp. nov. **Adambulacral armature and the pedicellariæ among** the spines of the armature. **The usual type of bivalved pedicellariæ is also shown close to the armature.** (× 4.)

Fig. 3.—***Tamaria tuberifera*** (Sladen). **Abactinal view of** smaller **specimen,** R = 22 **mm.** (× 2.)

PLATE V.

Fig. 1.—***Pseudogoniodiscaster wardi*** **gen.** et **sp. nov. Actinal view of holotype (Slightly under natural size)**

Fig 2.—***Pseudogoniodiscaster wardi*** **gen. et sp. nov. Portion of actinal surface of holotype showing details of plates and** pedicellariæ (× 4.)

Fig. 3.—***Pseudogoniodiscaster wardi*** gen. et sp. nov. **Portion of abactinal surface of holotype showing details of plates and papular areas** (× 4.)

PLATE VI

Fig. 1 —***Ferdina ocellata*** H. L. Clark Specimen from **North-west** Islet, **Capricorn** Group, **Queensland, which differs from** the **holotype in general appearance** Abactinal view. **(Slightly over natural size)**

Fig. 2.—***Ferdina ocellata*** **H** L. **Clark** Specimen **from Mer, Murray** Islands, **Torres** Strait, **which resembles holotype** Abactinal view (Slightly over **natural size)**

PLATE VII

Fig. 1 —***Nardoa mamillifera*** sp nov View of abactinal **surface** of holotype (Natural size.)

Fig 2 —***Nardoa mamillifera*** sp nov Adambulacral armature of holotype (× 4)

Fig. 3.—***Nardoa mamillifera*** sp nov Showing the series of four plates occurring between **the adambulacrals and inferomarginals of holotype.** (× 2)

Fig. 4.—***Nardoa mamillifera*** sp. nov. Details of abactinal **plates and** papular **areas** of holotype (× 2)

Fig 5.—***Nardoa mamillifera*** sp nov. **View** of actinal **surface of holotype.** (Natural size.)

PLATE VIII.

Fig. 1.—***Tamaria tuberifera*** (Sladen), **Adambulacral armature and surrounding** characters of **larger specimen** R = 66 **mm** (× 3.)

Fig. 2.—***Tamaria fusca*** Gray. Portion of **actinal surface showing** adambulacral armature. (× 3·5.)

Fig. 3.—***Tamaria tuberifera*** (Sladen) **Abactinal surface of three rays** of **larger specimen.** R. = 66 mm. **(Slightly under natural size.)**

Fig. 4.—***Tamaria tuberifera*** **(Sladen). Adambulacral armature and associated characters of smaller specimen.** R = 22 **mm.** (× 3·5.)

Fig. 5.—***Tamaria fusca*** **Gray. Abactinal surface. (Slightly under natural size.)**

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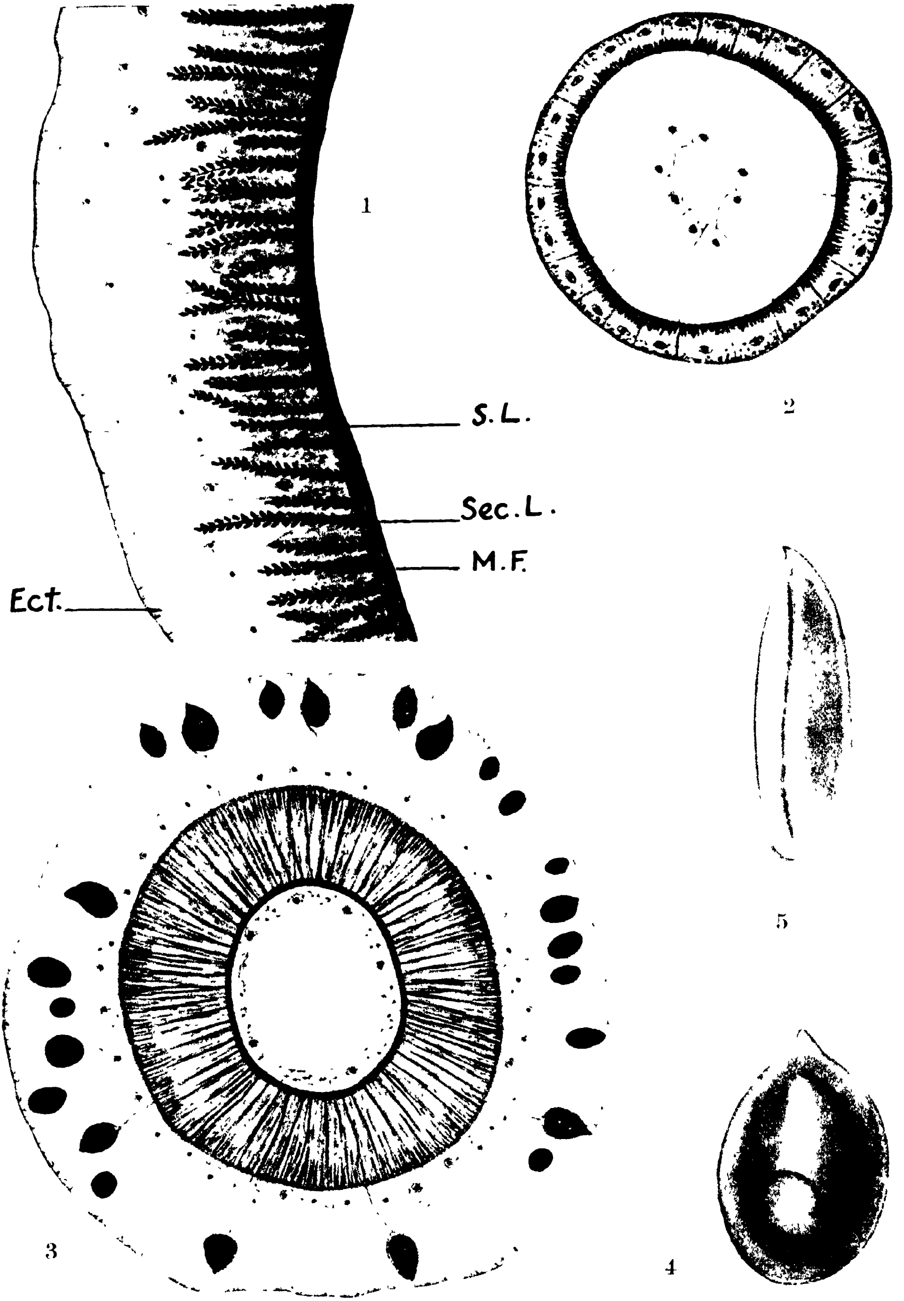

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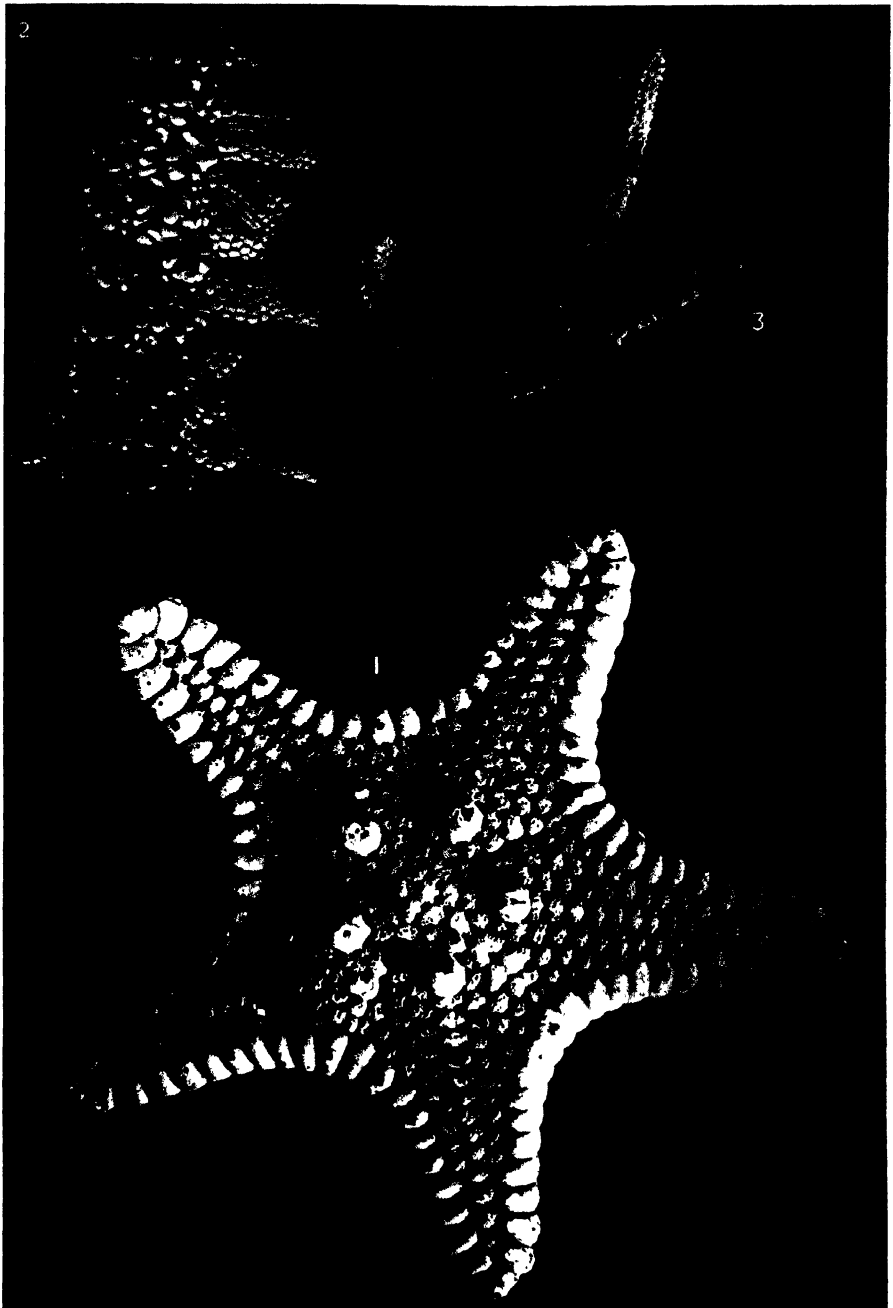

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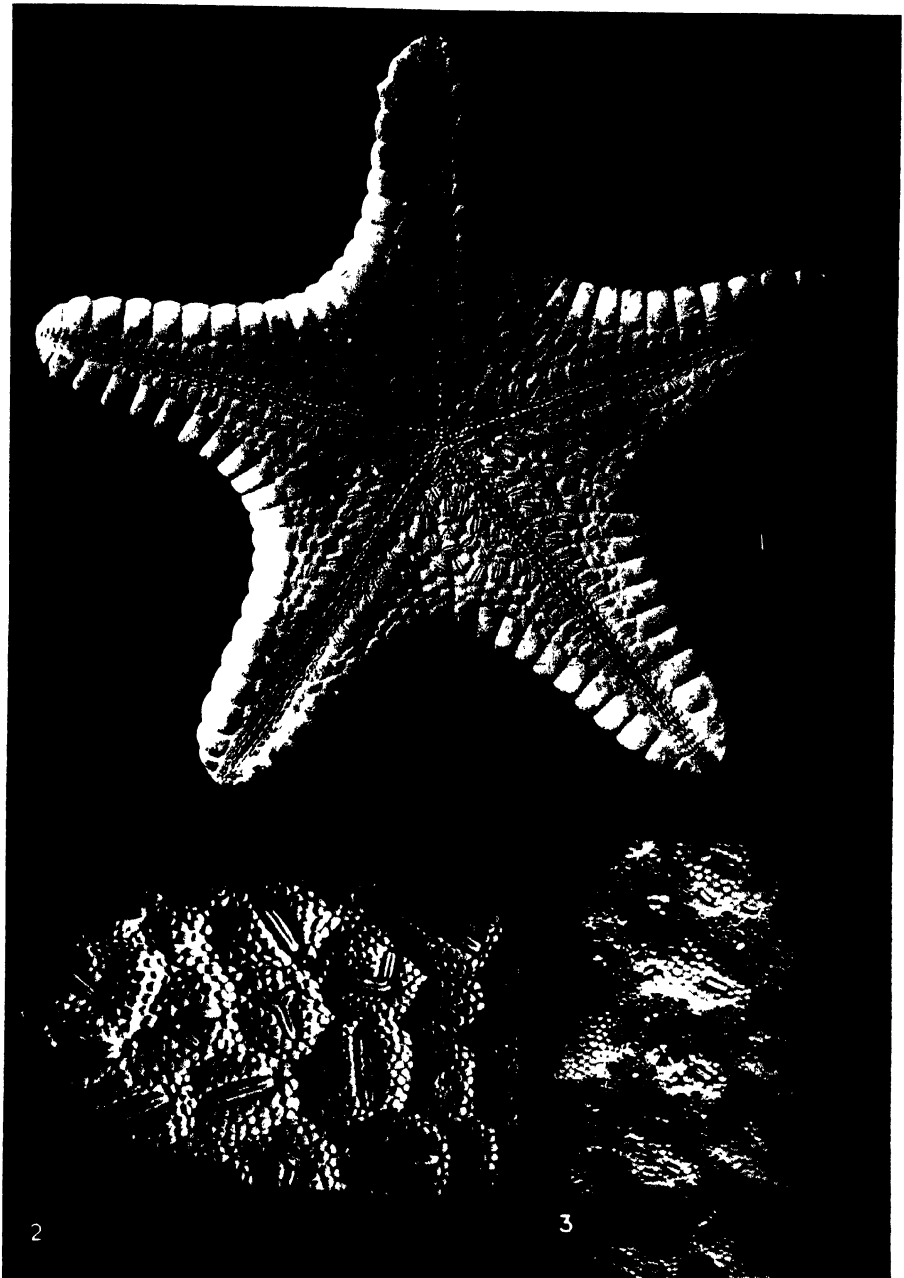

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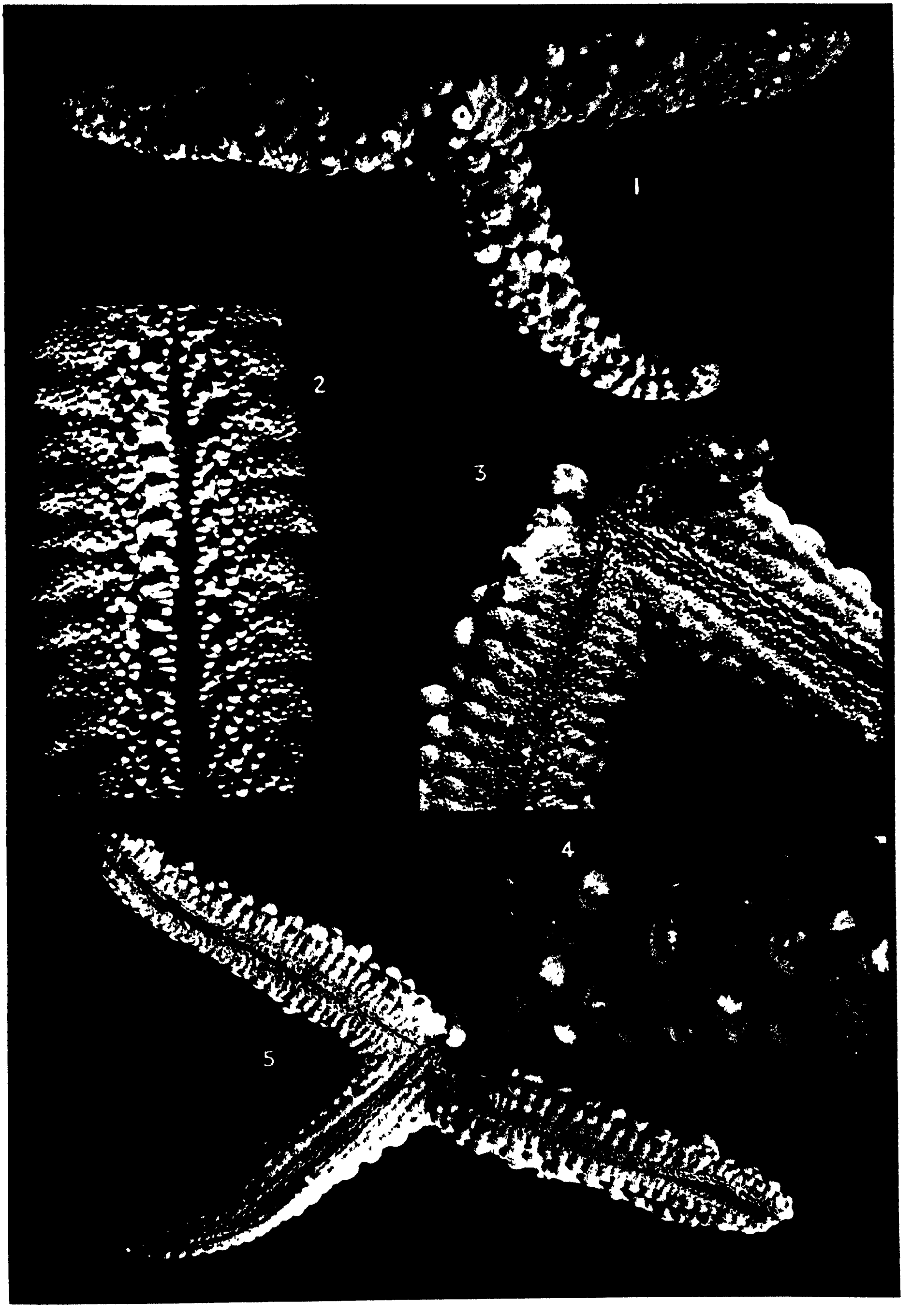

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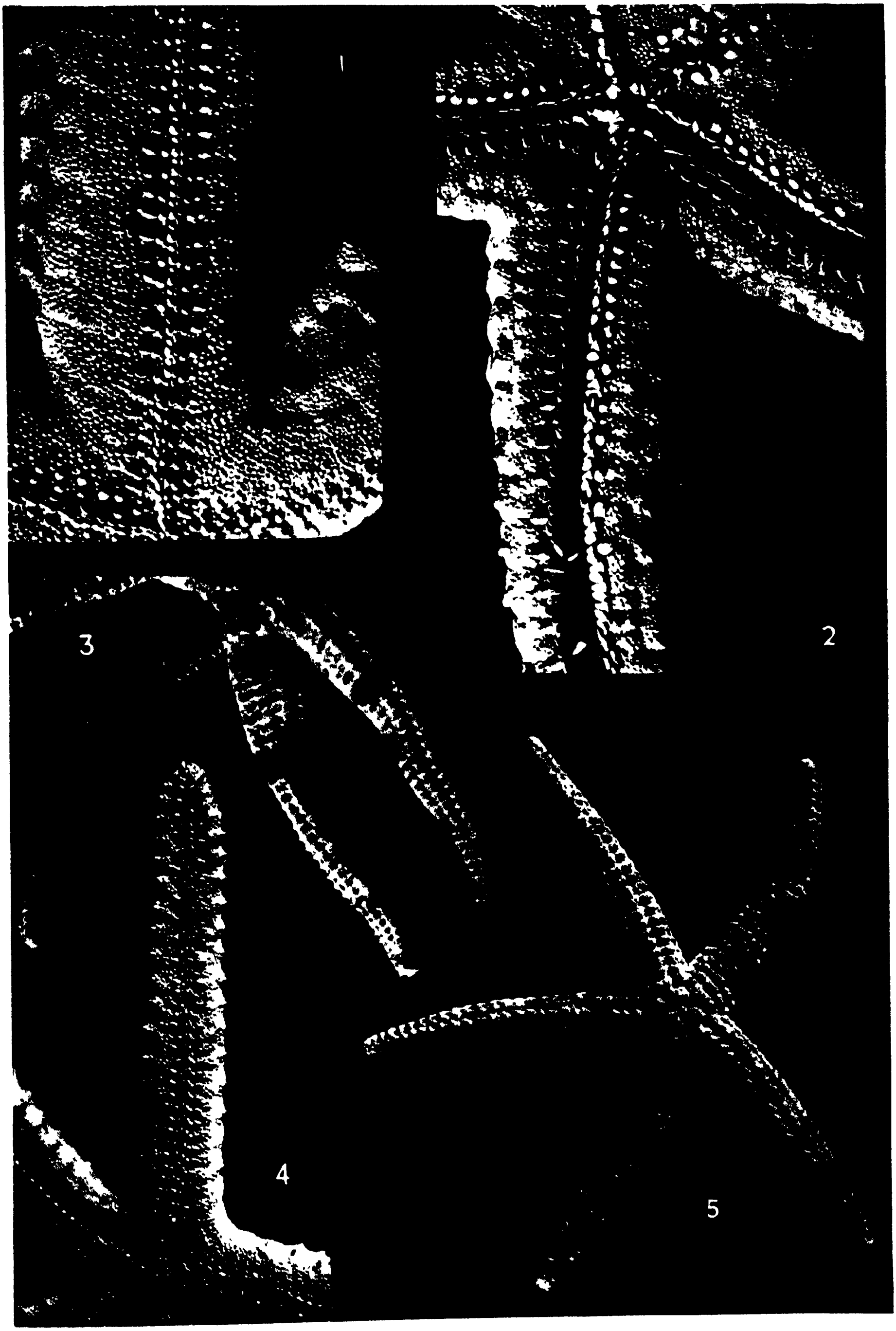
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FRESH-WATER SPONGES FROM AUSTRALIA AND NEW ZEALAND.

By

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I. Historical Notes.

Mr. L. P. Capewell, as far as we can discover from available literature, was the first person to collect a fresh-water sponge in Australia. This sponge was collected in Lake Hindmarsh, Victoria. Dr. J. S. Bowerbank in 1863 described[1] this sponge as a new species and illustrated it with a good drawing. The sponge being a new one was named for the finder and was called *Spongilla capewelli*; now that the nomenclature has changed somewhat, this species becomes known as (1) *Ephydatia capewelli* (Bowerbank). Mr. H. J. Carter, writing in 1881,[2] improved the original description somewhat. Later writers have also mentioned this form, but have added very little to the splendid descriptive notes made by Bowerbank and Carter.

Dr. W. A. Haswell, writing on "Australian Fresh Water Sponges" in 1883,[3] describes three new species and thus brings the total number of described species up to four at that date. It is very unfortunate that Dr. Haswell did not follow Dr. Bowerbank's example and leave us good drawings of the forms described. (2) *Spongilla sceptroides* Haswell, and (3) *Spongilla botryoides* Haswell, were both found in a pond near Brisbane, growing on submerged branches and twigs. Dr. Traxler illustrates the gemmule spicules of *S. sceptroides* in his paper[4] on the subfossil sponges of Australia, and Annandale gives a full description and illustrations of a specimen of this species from Queensland in a later paper.[5]

Mr. E. P. Ramsay had collected in Bell River at Wellington, New South Wales, another sponge which Haswell described and named (4) *Meyenia ramsayi*. This now becomes *Ephydatia ramsayi* (Haswell). Dr. Lendenfeld[6] has restudied *E. ramsayi* and gives us a fuller description than the original one and also provided illustrations of the form he examined.

Dr. Morris provided a few spicules of another species of *Ephydatia* from the Botany Reservoirs, near Sydney. These were quite different from both *E. capewelli* and *E. ramsayi*, but as Dr. Haswell does not describe this form we shall have to designate it for the present as (5) *Ephydatia ?*.

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[1] Bowerbank.—Proceedings Zoological Society of London, November 24, 1863, p. 447, pl. xxxviii.

[2] Carter.—Annals and Magazine of Natural History, (5), vii, 1881, p. 93.

[3] Haswell.—Proceedings Linnean Society of N.S.W., vii, 1883, pp. 208-210.

[4] Traxler.—Földtani Közlöny, xxvi, 1896, pp. 95-97, pl. iii.

[5] Annandale.—Proceedings U.S. National Museum, xxxvi, 1909, pp. 627-632.

[6] Lendenfeld.—Zool. Jahrb., ii, 1887, p. 91, pl. vi.

Dr. R. von Lendenfeld in the paper cited lists (1), (2), (3) and (4) of the above-named species and in addition adds (6) *Spongilla lacustris* var. *sphærica* found in the neighbourhood of the copper works of Cobar, New South Wales, and (7) *Tubella nigra* found in a swamp near Sydney, New South Wales, as new records for this region. This last form is illustrated with several drawings. He also suggests that (4) *Ephydatia ramsayi* (Haswell) is not entitled to more than varietal distinction, and that it should be called (*Spongilla*) *Ephydatia fluviatilis* var. *ramsayi*.

Mr. D. Vernon reports[7] the finding of fragments of spicules of fresh-water sponges in 1887 in the diatomaceous earth from the Tertiary beds of Warrumbungle Mountain, near Coonamble, New South Wales. He was not able to place the spicules as belonging to any one species and simply records it as a *Spongilla*.

Mr. Whitelegge, writing in 1889, records[8] finding a fresh-water sponge in Wooli Creek, Cook's River, Botany Bay, New South Wales, which Weltner places among the unidentified forms in his "Spongillidenstudien III".

Dr. Weltner in 1895[9] questions the new variety *S. lacustria* var. *sphærica* of Dr. Lendenfeld and states (p. 119) that, after the examination of some of the original specimens in which no gemmules are found, that he is not even certain whether this form really belongs to the genus *Spongilla*. It would then seem best either to delete this name from the list for the present or leave it with a question mark and thus record the fact that an unknown sponge has been found in that locality and make an effort to secure, if possible, from that place additional material bearing gemmules.

In this same paper Dr. Weltner disagrees with Dr. Lendenfeld's change of status of (4) *E. ramsayi* from a distinct species to a variety of *E. fluviatilis*, and remarks (p. 127) that he considers that the characteristics of both the skeleton spicules and the gemmule spicules of this sponge are so different from those of *E. fluviatilis* that *E. ramsayi* should stand as a species. Thus Dr. Lendenfeld, in the paper above referred to, makes only one addition which is entitled to recognition to the fresh-water sponge fauna of Australia, viz., (7) *Tubella nigra* Lendenfeld. We now propose to call this *Ephydatia nigra*.

Dr. Weltner, however, added in this same article the description of another new species which he called (8) *Tubella multidentata*, but which now becomes *Ephydatia multidentata* (Weltner). This sponge was collected by Mr. R. Semon in the Burnett River, Queensland.

Dr. Traxler, in 1896,[10] gives us the result of his investigation of a sponge which was collected by Mr. Chilton in the Kakahu River, Canterbury, South Island, New Zealand, and concerning which Mr. Chilton published a note[11] entitled "A New Zealand Fresh-water Sponge" in 1883. Dr. Traxler describes and illustrates this form fully and gives it the name (9) *Ephydatia kakahuensis*. Dr. Kirkpatrick, writing in 1921,[12] records this same species as collected by Mr. H. Hill from

[7] Vernon.—Department of Mines, N.S.W., Annual Report, 1887 (1888), pp. 165-166.
[8] Whitelegge.—Journ. and Proc. Roy. Soc. N.S.W., xxiii, 1889, p. 306.
[9] Weltner.—Archiv für Naturgeschichte, i, 1895, p. 119.
[10] Traxler.—Termez. Fuzetek, xix, 1, 1896, pp. 30-33.
[11] Chilton.—New Zealand Journal of Science, i, 1883, pp. 383-384.
[12] Kirkpatrick.—Ann. Mag. Nat. Hist., (9), viii, 1921, pp. 400-401.

Lake Taupo in the centre of North Island, New Zealand. Dr. Lendenfeld also observed this form, but called it "*Ephydatia fluviatilis*".

Dr. Weltner in 1900[13] records (10) *Spongilla fragilis* as occurring in the Murray River, Australia.

Mr. F. W. Hutton records[14] in 1904 (11) *Spongilla lacustris* as occurring in New Zealand.

Dr. Traxler also records, in another article[15] in 1896, that he has found in the alluvial diatomaceous earth of Geelong, Victoria, spicules of the following subfossil species: (2) *Spongilla sceptroides*, (12) *Ephydatia fluviatilis*, and a new species which he dedicates to Dr. Lendenfeld as (13) *Ephydatia lendenfeldi*.

Dr. W. Weltner writing in 1910 describes[16] in detail (14) *Ephydatia multiformis*, a new species from Herdsman's Lake, near Subiaco, Western Australia.

In order to make this record as complete as possible we will add references to three additional works in which mention is made of fossil or subfossil spicules of fresh-water sponges. Mr. F. Barnard[17] records the occurrence of unidentified sponge spicules; Mr. Etheridge[18] records the presence of spicules of *Ephydatia* and *Spongilla* in a deposit of pre-Pleistocene diatomaceous earth in the Warrumbungle Mountains, New South Wales; and Mr. F. Chapman in 1922[19] describes the finding of certain fresh-water sponge spicules in opal nodules from Tintenbar, Richmond River, New South Wales. These spicules were identified as probably belonging to *Ephydatia capewelli*, *Ephydatia ramsayi*, and some others to the genus *Spongilla*.

To summarize, the following fresh-water sponges are recorded from Australia and New Zealand:

1. (*Spongilla*) *Ephydatia capewelli* (Bowerbank).
   Victoria: Lake Hindmarsh. New South Wales: ? Tintenbar, Richmond River.
2. *Spongilla sceptroides* Haswell.
   Queensland: Near Brisbane; Lillesmere Lagoon, Lower Burdekin River. New South Wales: Bunnerong Road, Sydney. Victoria: Geelong (subfossil).
3. *Spongilla botryoides* Haswell.
   Queensland: Near Brisbane. North Australia: Ten Mile Station, Port Darwin.
4. (*Myenia*) *Ephydatia ramsayi* (Haswell).
   New South Wales: Bell River, Wellington; in Macquarie River, near Dubbo; ? Tintenbar, Richmond River. Also in Argentine, in Paraguay and in New Guinea.

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[13] Weltner.—*In* Semon's Zool. Forschungsr. in Australien, v, 5, 1900 (Denkschr. Medic. Naturw. Ges Jena, viii), pp 517-524.

[14] Hutton.—Index Faunæ Novæ Zealandiæ, London, 1904, p. 323.

[15] Traxler.—Földtani Közlöny, xxvi, 1896, pp. 95-97, pl. iii.

[16] Weltner.—*In* Michaelsen and Hartmeyer, Die Fauna Südwest Australiens, iii, 1910, pp. 137-144.

[17] Barnard.—Quart. Journ. Micro. Soc., Victoria, i, 1879, pp. 14-15, pl. i.

[18] Etheridge.—Ann. Rept. Dept. Mines, N. S. Wales, 1887 (1888).

[19] Chapman.—Proc. Roy. Soc. Victoria, xxxiv, 1922, pp. 167-171.

? 5. (*Myenia*) *Ephydatia ?*.
New South Wales: Botany Reservoirs, near Sydney.

? 6. Unknown Sponge (*Spongilla lacustris* var. *sphærica* Lendenfeld).
New South Wales: Near copper works, Cobar.

7. (*Tubella*) *Ephydatia nigra* (Lendenfeld).
New South Wales: Swamp near Sydney; Moore Park, near Sydney, in pond now filled up; Wooli Creek, Cook's River. Also a pond in Victoria.

8. (*Tubella*) *Ephydatia multidentata* (Weltner).
Queensland: Burnett River. South Australia: Cooper's Creek, 1924.

9. *Spongilla fragilis* Leidy.
Murray River in southern Australia.

10. *Spongilla lacustris* (L.).
New Zealand.

11. *Ephydatia kakahuensis* Traxler.
New Zealand: Kakahu River, Canterbury, South Island; Lake Taupo, North Island; Lake Takapuna, Auckland, North Island; creek near Invercargill, South Island.

12. *Ephydatia fluviatilis* auct. (subfossil).
Victoria: Geelong (*E. haswelli* Lendenfeld, no locality given). New South Wales: ? Woronora River.

13. *Ephydatia lendenfeldi* Traxler (subfossil).
Victoria: Geelong; New South Wales: Cambewarra Mountains; Ungarie. Western Australia: Waneroo Lake, near Perth.

14. *Ephydatia multiformis* Weltner
Western Australia: Herdman's Lake, near Subiaco; Two People Bay pumping station, near Albany. New South Wales: Toronto, Lake Macquarie.

II. Descriptive Notes.

Some months ago the authorities of the Australian Museum kindly sent for examination the small collection of Australian fresh-water sponges in their possession. This collection, together with some small bits of sponges from Australia, from the Berlin Zoological Museum, the Indian Museum and the British Museum (Natural History), and also some small bits from Professor G. E. Nichols and from Mr. E. W. Bennett, M.Sc., has enabled us to prepare the following descriptions which will serve as a summary of our present knowledge and a basis for further study of this very interesting group from that part of the world.

Mr. S. W. Ling, of Yenching University, Peiping, China, has kindly made the excellent drawings which accompany the descriptions. We wish, here, to express to Dr. W. Arndt our thanks for his many kindnesses in furnishing from his splendid collection in the Berlin Zoological Museum, slides and specimens, and also for reading over the manuscript before its publication.

We would like also to call attention to the fact that the *Ephydatias* from Australia have, in a great many cases, the rotules unequal. This characteristic is

unique for that region and it is doubtless deserving of some special recognition in the nomenclature of the several species. For the present, however, we prefer to use simply the generic names already assigned to them. We believe that before much longer a careful study and revision of the nomenclature of the group should be made, and when this is done it will be time enough to rearrange the terminology. Our present object is to furnish the necessary facts for a further study of this interesting group of animals by those who are interested in them and we trust that this paper may stimulate more extensive collections for such a study in the near future. The writer would be very grateful for gemmule-bearing specimens of fresh-water sponges bearing gemmules from all parts of Australasia.

Spongilla botryoides Haswell, 1883.

(Figure 1).

Historical Statement.—This sponge was first collected by Haswell from a pond near Brisbane and was described by him[20] in 1883. Lendenfeld in 1887 repeated[21] the original description, but adds nothing to our knowledge and states that he has not seen the sponge.

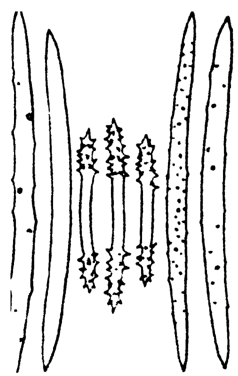

FIGURE 1
Spongilla botryoides.
Skeleton and gemmule spicules

Through the kindness of the Australian Museum we have recently received a specimen which we take to be this species. This specimen (No. 54769) was collected by A. A. Livingstone of the Australian Museum in July, 1929, the dry season for that part of Australia, from a small lake at Ten Mile Station, Port Darwin, North Australia.

Habitat.—The sponge was collected on the dead stalks of grass around a small lake. It was, in the majority of cases, dry when collected, but had, of course, grown on the grass while it was still covered during the high water season. The original specimens were found growing in a pond on submerged branches and twigs. They formed flat crusts on their supports.

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[20] Haswell.—Proc Linn Soc. N S W., vii. 1883, p 209.
[21] Lendenfeld.—Zool Jahrb, ii, 1887, p. 89

General Characteristics.—Unfortunately the specimens recently submitted to me for examination by the Australian Museum were badly broken when received. Two pieces, both growing around small grass stems and with a total diameter of about 2 cm. and a length of about 4½ cm., give us some idea, however, of how the sponge grew. It is largest in the centre and gradually becomes smaller toward its ends. The outer surface is smooth. There are no conspicuous oscula. The inner portion of the sponge is loosely constructed, being full of canals.

Colour.—In the larger pieces it has a light brown colour in alcohol; the smaller bits when free from sediment are quite clear and transparent.

Structure.—The skeleton is rather fragile. The main skeletal fibres, which radiate in lines about perpendicular to the small grass stalk on which the sponge was growing, are very thin, being composed of from two to five or six spicules, but can be clearly distinguished. We can detect no regular, continuous, transverse fibres, though the main ones are bound together by irregular meshes of about the length of the skeleton spicule. These meshes are very thin, the sides often being composed of only one or two spicules. The amount of spongin is small.

Skeleton Spicules.—These are gently curved, spindle-shaped, and usually gradually and sharply pointed at their ends; some few are more abruptly pointed. The surfaces of the spicules vary from being covered by exceedingly fine granulations, not spines, visible under only high powers of the microscope, to bearing a few scattered, readily seen, sharp spines.

Length: 280–315 μ. Thickness: 12–19 μ.

Haswell thus described those examined by him: "curved, fusiform, acute, usually with scattered, extremely minute projecting points".

Flesh Spicules.—There are no flesh spicules present.

Gemmules.—The gemmules are abundant, dark brown in colour, spherical in shape and are scattered singly throughout the body of the sponge. They are held in position by the meshes of the skeleton and are readily dislodged when the sponge is handled. The granular coat surrounding the gemmule is very thickly packed with the very characteristic spicules, which are lying embedded in it chiefly at an angle to the surface. Only a few in a tangential position were observed. They are woven into a very thick mass over the entire surface of the gemmule and form an effective covering. Usually the pore tube does not extend beyond the granular coat which covers the gemmule, but two or three gemmules have been observed with pore tubes projecting beyond the surface, and these tubes were also covered by a granular coat, in which numerous gemmule spicules were embedded.

Diameter: 307–383 μ.

Gemmule Spicules.—The gemmule spicules are mostly straight, though some are gently curved. In the centre the spicules are smooth, only rarely bearing one or more spines, but for about one-fourth or more of the length of the spicule, at each end, there are comparatively large perpendicular spines covering it; these spines are largest toward the middle of the spicule and become smaller and more numerous nearer the tips. The spicules always end in a sharp spine or point. In some of the spicules the spines appear to be blunted.

Length: 66–70 μ. Thickness: 3–4 μ.

Haswell thus describes the gemmule spicules of his specimen: "short, strongly curved spicules which are provided at each end with a head composed of numerous short, blunt or subacute spines producing a somewhat botryoidal appearance; the intermediate curved shaft is free from spines".

Type.—The location of the type of this species is not known. The specimen under examination is being deposited in the Australian Museum at Sydney. A small specimen is being retained in my collection.

Distribution.—Up to the present this sponge is known only from the type locality, Brisbane, and from Ten Mile Station, near Port Darwin. Doubtless it will be found in other places in northern Australia.

Remarks.—Unfortunately we do not have a type specimen or drawings of the original *S. botryoides* for comparison with this sponge. Haswell's description of that species is so inadequate that it does not give us a very clear idea of what that sponge is like. His indefinite description calls attention, however, to two or three points which correspond to the sponge in hand.

1. Its habit of growth—on twigs.
2. The description of skeleton spicules might apply to those of the Port Darwin specimen.
3. An active imagination and a poor microscope might help one to see the ends of these spicules as resembling a bunch of grapes. They do not suggest this to the writer.

Haswell speaks of the gemmule spicules as being "strongly curved"; in this sponge they are prevailingly straight or very slightly curved.

We call this sponge *S. botryoides* tentatively until collections can be again made in Brisbane.

Spongilla fragilis Leidy.

(Figure 2.)

Historical Statement.—This species was first described by Leidy in 1851.[32] Since then it has been redescribed many times.

Weltner[33] states that the Berlin Museum possesses several fragments of this species with gemmules which originated from Murray River in southern Australia. Annandale[34] also records this species as occurring in Australia. Neither of them calls attention to any variations from the typical form, so we give a description of the common forms of this species found in many places over the world. We have not seen the material from Australia representing this species. Our illustration is from an American specimen.

Habitat.—*S. fragilis* grows in both running and standing and even in stagnant waters, though it seems to thrive best in still waters. It grows on stone surfaces, on timbers or similar supports, and sometimes covers comparatively large areas.

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[32] Leidy.—Proc. Acad. Nat. Sci., Philadelphia, 1851, p. 278.

[33] Weltner.—*In* Semon's Zool. Forschungsr. in Australien, v, 5, 1900 (Denkschr. Medic. Naturw. Ges. Jena, viii), p. 523.

[34] Annandale.—Fauna of British India—Freshwater Sponges, Hydroids and Polyzoa, 1911, p. 96.

General Characteristics.—*Spongilla fragilis* forms flat, lichenoid patches, never of very great thickness, on almost any kind of support. Cases are recorded where these patches covered as much as two or three square feet, but were not more than an inch in thickness at the centre and shaded down to very thin filmy edges. Most of the specimens we have examined are smaller and thinner than the thickest portion of the one mentioned above. We have specimens forming small patches two or three centimetres in diameter and less than a centimetre in thickness.

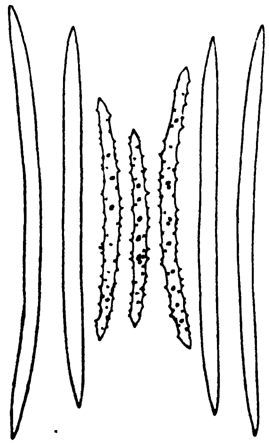

FIGURE 2.
Spongilla fragilis.
Skeleton and gemmule spicules.

The surface of the sponge is generally smooth or slightly tuberculated. The oscula are numerous and clearly visible and the confluent radiating canals often give them a star-like appearance.

Colour.—This sponge may be almost white in very clean water, or at times it is quite black as in some of our specimens. The prevailing colours are probably greyish or brownish. Some green sponges have been recorded, but those of that colour are not so abundant as is the case in *S. lacustris*.

Structure.—Vertical main skeletal fibres and horizontal transverse ones are well defined and they form a dense firm network. The amount of spongin is small and for this reason the structure can be readily crumbled.

Skeleton Spicules.—The skeleton spicules are straight or only slightly curved, rather thin, spindle-shaped, smooth and gradually and sharply pointed. They range from about 180 to 255 μ in length and from 5 to 16 μ in thickness.

Flesh Spicules.—None are present.

Gemmules.—The gemmules are abundant, arranged as a rule in a pavement layer or layers at the base of the sponge; each gemmule is enclosed in a thick cellular covering several layers thick, and they are also bound together in free groups of two, three, or more, by a common cellular covering. The foraminal

tubule is a simple, usually curved, tube which always projects outward through the surrounding individual gemmule coat; at times more than one tubule may be borne by a single gemmule. The gemmule spicules lie embedded in these air cell layers. The gemmules are as a rule spherical, but often under pressure their shape may become somewhat polygonal. They are small, measuring in diameter usually from 250 to 350 μ, but at times there are those which measure as much as 500 μ. The diameter varies a good deal due to the varying thickness of the air bubble cell layer.

Gemmule Spicules.—The gemmule spicules are usually straight, or slightly curved, cylindrical, or slightly tapering, blunt or abruptly pointed or often ending in a single terminal spine. They are covered all over with erect spines of varying size and these are often largest near the ends of the spicules. They range between 68 and 125 μ in length and from 3 or 4 to 8 to 10 μ in thickness.

Type.—Potts states that the type is preserved in the Academy of Natural Science, Philadelphia, U.S.A.

Distribution.—This is another cosmopolitan species. Both Weltner and Annandale record the typical form of this species from Australia, the former from Murray River and the latter from no special locality.

Remarks.—This sponge can be easily distinguished from all other species found in Australia to date by the peculiarities of the arrangement of its gemmules in small groups surrounded by a common cellular coat, and by the long, usually curved, foraminal tubes projecting through its coat to the outside.

Spongilla lacustris Linnæus.

(Figure 3.)

Historical Statement.—*Spongilla lacustris* is one of the earliest species of fresh-water sponges recorded and was included by Linnæus in his Systema Naturæ, Ed. 10, Vol. 2, p. 1348, in 1759.

Our authority for placing this sponge in the list of sponges from the fresh waters of Australasia is its record in Hutton's "Index Faunæ Novæ Zealandiæ", London, 1904, p. 323. He gives as his basis for this record Chilton in "New Zealand Journal of Science", Vol. I, 1883, pp. 383 and 572. We have access to the first reference, which, according to Traxler, is to *Ephydatia kakahuensis*; the one on page 572 we have not seen.[25] Our description is a general one and will help one in identifying this sponge if he happens to find it in Australia.

Habitat.—*S. lacustris* may grow in swiftly running streams or in quiet stagnant waters and its form is adjusted to its place of growth.

General Characteristics.—It is a very variable species and we can only give a few of its outstanding characters. "As found in infinite numbers of situations

[25] The complete reference on page 572 is reprinted herewith:

"A New Zealand Fresh Water Sponge—The sponges preserved in the Canterbury Museum have lately been examined by Dr. v. Lendenfeld. Among them was a specimen of the fresh water sponge, found by me in the Kakahu River (see page 383 of this Journal). Dr. Lendenfeld finds that this is *Spongilla fluviatilis*, the fresh water sponge found in running streams in England.—C[HARLES] C[HILTON]."

Editor, RECORDS OF THE AUSTRALIAN MUSEUM.

and variety of forms in North America, this sponge is green, when growing, as it does by preference, in the light: from a sessile base freely and repeatedly branching; branches cylindrical or more or less tapering; bristling with points of radiating spicules; ends of the branches pointed or rounded" (Potts).[26] Some specimens in our collection from Lake Kizaki, Japan, suggest a very much

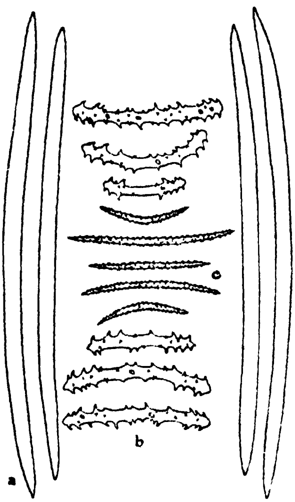

FIGURE 3.
Spongilla lacustris.
a, Skeleton spicules. *b*, Gemmule spicules. *c*, Flesh spicules

branched deer antler in appearance. Other specimens are simple masses or clumps of small size: these are usually taken from swiftly moving waters: even these often bear short finger-like projections. Oscula are surrounded by well developed collars, moderate in size and made conspicuous by furrows which radiate from them.

Colour.—Often this sponge is green in the light; sponges growing in the shade may be greyish, yellowish or varying shades of brown.

Structure.—"Texture loose; the branching process made up of thick longitudinal lines of fasciculated spicules, united by single spicules or more slender fascicles, in a radiating manner."[27] These longitudinal fibres extend throughout the branches in branched specimen. The spongin is usually well developed.

Skeleton Spicules.—The skeleton spicules are slightly curved, rarely straight, smooth, thin, gradually and sharply pointed. They vary from about 200 to 330 μ in length and 6 to 15 μ in thickness.

Flesh Spicules.—The flesh spicules are small, 70 to 130 μ by 2 to 8 μ, usually slightly curved, sometimes crescent-shaped, rarely straight, more or less thickly covered with small spines. Usually they are gradually and sharply pointed,

[26] Potts.—Proc. Acad. Nat. Sci., Philadelphia, 1887, p. 187.
[27] Potts.—*Loc. cit.*, p. 187.

though sometimes those with bluntly rounded ends may be present. The number of these spicules in the parenchyma is very variable, often they are very numerous.

Gemmules.—The gemmules are spherical in shape and variable in size, from 500 to 800 μ in diameter; most of those we have measured are between 500 and 600 μ in diameter, but were without the granular coat. They are scattered throughout the entire skeleton and lie freely in its reticulations. They are usually covered with a thick granular coat in which the spicules are placed more or less tangentially; this coat varies much in thickness and at times may be altogether lacking. There is no projecting pore-tube, but its place may be taken by "an open, bowl-shaped chitinous structure the base of which is in continuity with the inner chitinous coat of the gemmule".

Gemmule Spicules.—"Gemmule-spicules resembling the flesh-spicules but are shorter, and as a rule more strongly curved, sometimes bent so as to form semicircular figures, usually pointed somewhat abruptly; their spines are relatively longer than those of the flesh-spicules, often curved backwards, especially near the ends of the spicules, at which points they are often longer than elsewhere."[28] They vary from 80 to 130 μ in length and from 3 to 10 μ in thickness.

Type.—No recognized type of this species is in existence. It has been described many times by many authors and in many languages.

Distribution.—In range it is practically cosmopolitan and is one of the commonest species. Its occurrence in Australasia needs confirmation, since it is not at all certain that it has been found there.

? **Spongilla lacustris** var. **sphærica** Lendenfeld, 1887.

(Figure 4.)

Historical Statement.—In 1887 Lendenfeld described[29] a sponge from near Cobar copper works in New South Wales as a new variety of *S. lacustris* and designated it as variety *sphærica.*

He found no gemmules and his identification of the variety has been called into question. In order to make our record as complete as possible and to make available to future students of Australia's fresh-water sponges all previous records, we will give what is known of this sponge.

The following description is based upon Lendenfeld's original description and upon our observations upon three of Weltner's slides, marked as this variety, from the University Zoological Museum of Berlin.

Habitat.—Lendenfeld states that he found this sponge among large quantities of smaller specimens, on a *Chara* plant in a pool of slightly brackish water, rich in magnesia, which at times became altogether dry. After years of drought it was filled after a heavy rainfall and remained with water in it for a period

[28] Annandale.—Fauna of British India—Freshwater Sponges. Hydroids and Polyzoa, 1911, p. 70.
[29] Lendenfeld.—Zool. Jahrb., ii, 1887, p. 90.

of about six months to a year. The region where these pools were found was not a part of the river bed. Within this flat area the centre of each pool is its deepest part. This sponge was found a month after a heavy rainfall, which occurred after an absolute drought of three years.

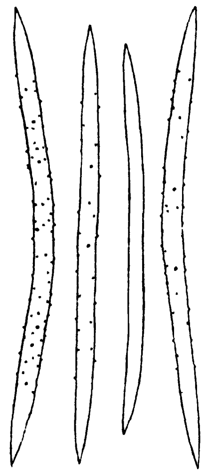

FIGURE 4.
Spongilla lacustris var. *sphærica.*
Skeleton spicules.

General Characteristics.—The sponges are round or oval and are without prolongations. The largest specimens are oval and are from 15 to 20 mm. in diameter.

Structure.—The skeleton is composed of the usual spicule bundles or single spicules.

Skeleton Spicules.—Lendenfeld states that the skeleton spicules are spindle-shaped, slightly spined, gradually pointed and about 180 μ in length; their thickness in the centre is 8·6 μ. The spines have a much wider base than is usual on the spicules and are not very sharply pointed; they reach a length which is equal to about one-fourth of the thickness of the spicule.

Through the kindness of Dr. Arndt I have been able to examine three of Weltner's slides labelled *Spongilla lacustris* var. *sphærica.* These slides contain only the skeleton spicules, a very careful search not revealing even one flesh spicule characteristic of *S. lacustris.* Weltner also failed to find them. The skeleton spicules on these slides are slightly curved and usually thickly covered with small spines except near their sharpened tips. The type of point at the ends of the spicules varies; some taper gradually from the centre to very sharp points at their ends, others are more cylindrical, tapering only slightly, but near the ends abruptly become sharp-pointed. These spicules also measure much larger in every way than those recorded by Lendenfeld, for they vary from 239 to 323 μ in length and 8 to 14 μ in thickness, averaging around 280 to 290 μ in length and 9 to 11 μ in diameter. With these larger spicules are found

numerous small, slender, smooth, very sharply pointed spicules which we consider the young skeleton spicules.

These spicules closely resemble those of other Australian sponges.

Flesh Spicules.—Lendenfeld describes the flesh spicules of a typical *S. lacustris* as being slender, spindle-shaped, spiny throughout and gradually pointed. He adds concerning these spicules of his variety *sphærica* that flesh spicules of varying dimensions were observed, but that they were rare. I could find none in the three of Weltner's slides examined.

Gemmules.—No gemmules were found, consequently the final determination of the variety is doubtful.

Type.—The Berlin Museum contains some of the original material, but not the type. We can find no reference to the location of the type, and it would be most helpful to have further collections of sponges bearing gemmules from the type locality in order to settle the question of this sponge's claim to stand as a variety.

Distribution.—Up to date it is reported only from the original locality in a temporary pond in the neighbourhood of the Cobar copper works in the interior of New South Wales.

Remarks.—The identity of this sponge remains very doubtful. Weltner[30] states that the identification is very uncertain so long as no gemmules have been found. He also says that he has studied three of the specimens of the original material and failed to find any flesh spicules. He even questions whether this is a *Spongilla* at all. We have also been unable to find any flesh spicules and question the determination made by Lendenfeld. We think it quite likely that these spicules may belong to an entirely distinct sponge, even of another genus.

Spongilla sceptroides Haswell, 1882.

(Figures 5–6.)

Historical Statement.—About 1880 Haswell first found a fresh-water sponge in a pond near Brisbane and sent a note describing this to the Linnean Society of New South Wales, but, hoping to secure additional material, he later withdrew his note from publication, and it was not until 1882[31] that he published his description of the above-named species.

Lendenfeld again described[32] this species, but adds little to the original description. Whitelegge[33] records it in 1889 from a new locality, Port Jackson. Traxler[34] records finding the spicules of this species in the diatomaceous earth deposits of Geelong, Victoria. Annandale[35] redescribed a sponge from the U.S. National Museum collection, which he considered to be this species.

[30] Weltner.—Archiv für Naturg., i, 1895, p. 119.
[31] Haswell.—Proc. Linn. Soc. N.S.W., vii, 1882, p. 209.
[32] Lendenfeld.—Zool. Jahrb., ii, 1887, p. 89.
[33] Whitelegge.—Journ. and Proc. Roy. Soc. N.S.W., xxiii, 1889, p. 306.
[34] Traxler.—Földtani Közlöny, xxxvi, 1896, p. 97.
[35] Annandale.—U.S. National Museum, Proceedings, xxxvi, 1909, pp. 627-629.

Through the kindness of the Australian Museum we have been privileged to examine the type of this species, but it bears no gemmules, so we have only been able to study the skeleton spicules. The U.S. National Museum has kindly given us a small bit of the material (No. 53930) described by Annandale from its collection as *S. sceptroides*. Our illustrations are from this specimen. In our description which follows we give our conclusions from these studies.

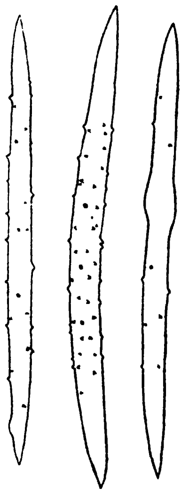

FIGURE 5
Spongilla sceptroides.
Skeleton spicules.

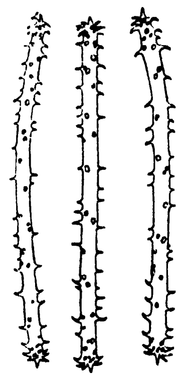

FIGURE 6.
Spongilla sceptroides
Gemmule spicules.

Habitat.—The type is a very small bit which was growing on a water plant. Haswell records that he found this sponge growing on submerged branches and twigs in a pond. Annandale says that the specimen he examined formed a mass coating a piece of stick. A second specimen from the Australian Museum marked as belonging to this species was similar to the type in that it formed very small, thin growths on a similar water plant; it was also, unfortunately, without gemmules.

General Characteristics.—"Encrusting, smooth, moderately elastic, not crumbling."[36] The sponge examined by Annandale was an "irregular mass, some 10·5 cm. long and 2 cm. thick. . . . The surface so far as it remains, is smooth, with fairly large oscula (about 3 mm. in diameter), which are not raised on eminences".

Colour.—Haswell and Whitelegge record their specimens as being green in colour. The dry specimen in the U.S. National Museum is a pale grey in colour. The alcoholic specimens from the Australian Museum are almost colourless, being only slightly tinged with a very pale brown.

Structure.—The type is too small a bit to show much definite structure, but both it and the other Australian Museum specimen seem to be made up of an

[36] Haswell.—*Loc. cit.*

irregular mass of meshes loosely woven together; no long or continuous rays are apparent. The specimen examined by Annandale he describes as follows: "The substance of the sponge is compact, the primary radiating fibers, but not the secondary transverse ones, being visible in vertical section to the naked eye as slender white threads."

Skeleton Spicules.—"Skeleton spicules very slightly curved, fusiform, acute at both ends, ornamented with scattered minute projecting points which only become visible under a fairly high power" (Haswell). Lendenfeld concludes from this that the skeleton spicules are cylindrical and suddenly pointed. They measure 250 μ long by 10 μ thick.

Annandale says: "The largest skeleton spicules measure 350 μ by 21 μ. They are straight or feebly curved and are covered with extremely minute projections in the central part of their length, the ends, which are sharply and cleanly pointed, being smooth. The projections are so minute that it is often difficult to see them. They are conical in outline, somewhat broad at the base in comparison with their length, and are rarely sufficiently numerous to give the spicule a roughened look under a low power of the microscope."

We find that the skeleton spicules from the type specimen are usually fusiform, tapering gradually from the centre to sharp-pointed ends; some of them are more uniform in thickness until near the ends, and become more abruptly sharp pointed. Sometimes they have a bulb-like enlargement in the centre. They are covered with very fine spines except near the sharpened ends, where they are invariably smooth. The number of spines varies considerably, some spicules bearing many more than others. A number of smaller spicules, which we consider to be immature, are found in our preparations. These slides contain two sizes of spicules, the larger ones measuring from 271 to 315 μ long and have a thickness of from 9 to 16 μ. The smaller ones range from 194 to 216 μ in length and are around 8 to 10 μ in thickness. The spicules of the type and of the other Australian Museum specimen are very similar.

The skeleton spicules of the U.S. National Museum specimen as compared with the type are considerably thicker, measuring from 18 to 24 μ, and have fewer but larger spines. They are also less curved and are often straight. They measure from about 264 to over 300 μ in length.

Flesh Spicules.—No flesh spicules were observed in this sponge.

Gemmules.—The gemmules are spherical. Annandale states that the gemmules in the specimen examined by him were practically colourless and numerous throughout the sponge. "In general structure they closely resemble those of *Spongilla lacustris.* They are spherical and measure on an average 520 μ in diameter. There is a thick granular coat, in which the spicules are arranged close together and tangentially, while an outer layer of horizontal spicules can be detected on the surfaces of some gemmules. The aperture of the gemmule, which is single, is provided with a stout foraminal tubule, which is generally more or less curved and projects through the granular coat."

Our examination of the gemmules in the specimen from the U.S. National Museum gives us the following results. They are dark brown in colour, spherical in shape, varying from 484 μ to 582 μ in diameter, the larger number measuring

around 540 μ. There is no very regular arrangement of the gemmule spicules in the granular layer around the gemmule; in addition to the positions described by Annandale we find numbers of them standing either perpendicular to the surface of the gemmule or inclined at an angle to it. In one gemmule we find the straight pore-tube projecting slightly beyond the surface of the granular coat, but this gemmule seems to have the granular portion somewhat worn away by handling.

Gemmule Spicules.—The gemmule spicules, according to Haswell, are long, slender, straight and cylindrical. They are armed with numerous acute spicules, chiefly aggregated round the extremities, where they form distinct heads, the intermediate shaft having but two or three very small spinules.

"The gemmule spicules", of the U.S. National Museum specimen, "measure from 126 μ to 147 μ in length. They are slender in proportion (transverse diameter about 4·2 μ) and straight or feebly curved. The spines which cover them with fair uniformity are about half as long as the spicule is thick; those in the middle are straight, those at either end curved and directed backward. As a rule the spicule terminates at either end in a single straight spine." Those illustrated by Traxler and assigned to this species lack the terminal spine, and the two are somewhat differently spined.

Our observations of the skeleton spicules agree in most details with those by Annandale. We find them to vary between 118 and 134 μ in length and 3·5 to 5 μ in thickness. In most of them, however, the spines are more thickly crowded near the ends, though the central portion of the spicule is never entirely free of spines.

Type.—The gemmuleless "type" of the species is preserved in the Australian Museum in Sydney, Australia. This specimen is labelled as coming from the Lillesmere Lagoon, Lower Burdekin River, whereas the type should be Haswell's specimen from Brisbane.

Distribution.—If we consider all the forms referred to above as belonging to this species, then it has been found in the following localities. Queensland: in a pond near Brisbane (Haswell); U.S. National Museum also possesses a specimen from this State. New South Wales: water reserve off Bunnerong Road (near Sydney). Victoria: Geelong (Traxler).

The "type" is marked "Lillesmere Lagoon, Lower Burdekin River, Queensland".

Remarks.—Annandale states that it is a close ally of *S. lacustris*, but that it can be distinguished from that sponge by the absence of flesh spicules and by the "armature of the aperture of the gemmule". It can be distinguished from *S. proliferens* by its "more compact and massive structure" and by its lack of flesh spicules.

We follow Annandale in assigning this sponge to the species *S. sceptroides* until further sponges are available from that region. We confess, however, that we do so with grave doubts, and that we cannot reconcile Haswell's statement that there are only two or three very fine spines in the middle of the shaft. In our specimens the spines are numerous in that portion of the shaft.

Ephydatia capewelli (Bowerbank), 1863.
(Spongilla capewelli Bowerbank, 1863.)
(Figures 7-8.)

Historical Statement.—This sponge was first described and illustrated by Bowerbank[37] as *Spongilla capewelli* from specimens collected from Lake Hindmarsh, Victoria, by E. P. Capewell. Carter described[38] it again, and Lendenfeld[39] further recorded it.

Habitat.—The specimen from which the original description was made was: "7½ inches long and 3 inches in greatest diameter, surrounding in a very irregular manner a small twig of wood not a quarter of an inch in diameter, and from which it projects in large tuberiform masses". It was collected upon the shores of the lake. Mr. Capewell writes: "In the winter season, about June, the weather being very tempestuous, the lake becomes greatly agitated, and the roll and swell is so great that at times a small boat can scarcely live upon the surface. It is

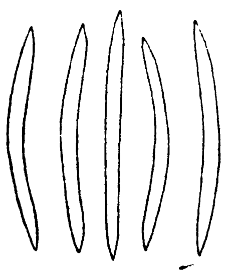

FIGURE 7
Skeleton spicules
Ephydatia capewelli

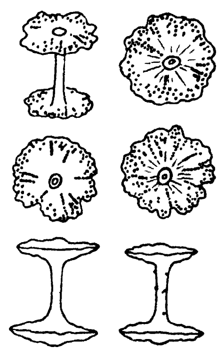

FIGURE 8
Ephydatia capewelli
Gemmule spicules.

after one of these storms that, by searching along the shores, one may obtain specimens. I have searched well for it among the reeds and upon the branches of the trees pendant in the water, but did not succeed in finding them in those situations, and my impression has always been that it coated dead branches of trees that had fallen some depth in the water."

General Characteristics.—"Sponge massive, sessile; surface uneven, often lobular, smooth. Oscula simple, minute, dispersed. Pores inconspicuous. Dermal membrane pellucid, aspiculous." I have not seen a large enough specimen of this sponge to form any idea as to its general form.

Colour.—"Colour dull green with a tint of yellow." A small dry bit of a cotype of this sponge kindly given me by Dr. Arndt of the Berlin Zoological Museum is a dirty light-brown in colour.

[37] Bowerbank.—Proceedings Zoological Society, London, 1863, pp. 447-448.
[38] Carter.—Ann. Mag. Nat. Hist., (5), viii, 1881, pp. 93-94.
[39] Lendenfeld.—Zoolog. Jahrb., ii, 1887, p. 93.

Structure.—"Soft and crumbly." Our small specimen shows an irregular network made up in the main of thin meshes bounded by one, two or three spicules, but with here and there thicker vertical fibres consisting of from four to six spicules. The amount of spongin is small.

Skeleton Spicules.—The skeleton spicules are usually curved, smooth, of almost a uniform diameter until near their ends, where they become abruptly and bluntly pointed. They vary a good deal in length and in diameter. Rare ones are slightly enlarged in the centre. They measure from about 272 to 323 μ in length, averaging around 285 μ. The thinner ones are as little as 12 μ in diameter, while the thickest may measure 20 μ. The average is around 16 to 18 μ.

Flesh Spicules.—No flesh spicules are present in this species.

Gemmules.—The gemmules are somewhat yellowish in colour when dry and are crowded together in the basal portion of the sponge; they are spherical in shape, but when dry often somewhat flattened. The surface is regular and smooth. The pore tube is simple and has a circular opening even with the surface of the outer protective layer of the gemmule. The gemmule is covered with a single layer of densely crowded birotulates and large numbers of the skeleton spicules are closely attached to this thick, outer, granular layer of the gemmule. We measured three gemmules and found them to be 619 μ, 697 μ and 731 μ respectively, in diameter.

Gemmule Spicules.—The birotulate spicules have a straight, usually smooth shaft, which is sometimes slightly inflated in the centre, forming a small bulb. The disks are at times about equal in diameter, though most of them have the outer disk very slightly smaller than the inner one. The margins of the rotules are "irregularly crenulo-denticulate", the indentations being as a rule only shallow ones, though sometimes deeper ones are present. Over the surface of the rotule are small granulations thickly scattered, especially around the outer edges of the disk, frequently forming radial rows extending toward the centre of the disk.

Bowerbank says that the shaft is "incipiently spinous"; our preparations from a cotype have smooth shafts with only very rarely any roughness at all upon them. The length of the birotulates varies from about 22 to 34 μ, with an average length of around 28 μ. The rotules vary from 20 to 28 μ in diameter, with the outer one often 2 to 4 μ smaller than the other.

Type.—The type of the species is preserved in the British Museum (Natural History). We have a small cotype in our collection.

Distribution.—This sponge is known from its original locality, Lake Hindmarsh, lat. 35° 30′ S., long. 141° 40′ E., Victoria, and is also reported by Chapman in 1922 from Tintenbar, Richmond River, N.S.W., as having been found in opal nodules. Doubtless a thorough exploration of the country would reveal its presence in other localities. Only very little work has as yet been done upon this very interesting group of animals from Australia.

Ephydatia fluviatilis auct.

(Figures 9–11.)

Historical Statement.—It is somewhat uncertain who is the author of this species, but it is probable that Linnæus first gave it its name *fluviatilis* in 1759 as

Spongilla fluviatilis.[40] Many good descriptions and illustrations of this common species are now available in more recent literature.

Chilton informed Traxler that his sponge from Kakahu River, New Zealand, had been identified by Lendenfeld as identical with *E. fluviatilis*, but Traxler found it so different from that species that he gave it a new name, *E. kakahuensis*.

Our record of the occurrence of this species in Australia is due to Traxler,[41] who found spicules of it in the diatomaceous earth at Geelong, Victoria.

In addition to the record of the Australia findings by Traxler we have been able to examine a specimen from the Australian Museum marked as the "type of *E. haswelli*, Lendenfeld". This last is clearly *E. fluviatilis*. We can find no reference anywhere in the available literature to a description of any such sponge as *E. haswelli* Lendenfeld! It must, therefore, be simply an error in the naming of the specimen. We also add tentatively the specimen from Woronora River to this species.

Our description is a general one for the species.

Habitat.—This sponge grows under very different conditions; it may be found in stagnant or in flowing water and in a few cases it has even been found in brackish water. It is one of the most common and most conspicuous forms.

General Characteristics.—The conditions under which this sponge grows have a very decided influence upon its general form and appearance. In rapidly flowing water the colonies become crust-like, while in still or slowly flowing waters larger and thicker masses are formed. In China we have seen masses 10 or 12 cm. at the base and as high as 15 cm. growing attached to a stone in a stagnant pond. In one slowly flowing stream it formed masses with a diameter of 30 to 40 cm. and a thickness in the centre of 8 to 10 cm., gradually becoming thinner toward the outer edges of the colony. At other times we have found it forming small, soft masses of irregular shape growing on water weeds. The surface is rarely smooth, it more often has irregular elevations and depressions and may at times bear lumps or rounded projections. It rarely forms long branches.

Colour.—The colour is as variable as the structure. When living in the light it may be green, due to the presence of a green alga; when it grows in shaded or dark places it is usually yellow to brown, white or a dirty-white in colour. The Australian specimen is a light brown in colour.

Structure.—In our Soochow, China, forms there are distinct radiating fibres which often send off smaller fan-shaped fibres in the upper portion of the sponge. The transverse fibres are also present, but are not so well defined. The whole mass is quite firm, but is fragile and readily crumbles to a powder under pressure, since the amount of spongin present is comparatively small. Bladder cells are lacking in the parenchyma of this sponge.

In the Australian specimen the radiating fibres are strong and clearly defined, and are knit together at intervals by the transverse connections, which do not seem to be regular enough to be defined as fibres. The entire structure

[40] Linnæus.—Systema Naturæ, edit. x, ii, 1759, p 1348.
[41] Traxler.—Földtani Közlöny, xxvi, 1896, pp. 96-97.

is held together by only small amounts of spongin and the thin section under the microscope is quite transparent.

Skeleton Spicules.—The common skeleton spicules are generally slightly curved, rarely straight, smooth, slender, gradually and sharply pointed, rarely abruptly pointed. These spicules vary a great deal, however, and short, thick, smooth spicules, or even at times slightly roughened or spined spicules may be present. Arndt states that they range from 180 to 550 μ in length and from 3 to 20 μ in thickness, but that they generally average between 250 to 370 μ in length and around 15 μ in maximum diameter.

The Australian Museum specimen, marked as the type of *E. haswelli*, has gently curved, smooth, spindle-shaped spicules, which are often comparatively thick in the centre. They are always sharp pointed, but sometimes rather abruptly sharpened. They vary in length from 238 to 331 μ and average around 300 μ long. In thickness they range from 14 to 22 μ and average around 16 or 17 μ.

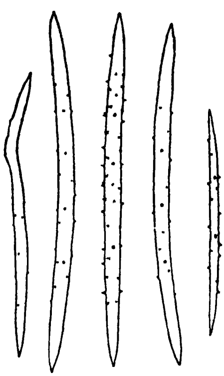

FIGURE 9.
Ephydatia fluviatilis.
Skeleton spicules.

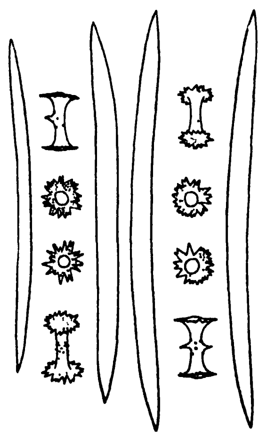

FIGURE 10
Ephydatia fluviatilis.
Skeleton and gemmule spicules

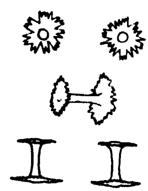

FIGURE 11
Ephydatia fluviatilis
Gemmule spicules.

Flesh Spicules.—There are no flesh spicules present in this species.

Gemmules.—In some cases the gemmules are scattered throughout the entire sponge, at other times they are crowded in large numbers at the base of the sponge, and in a few cases we have found small masses of them crowded together in a very small area up inside near the centre of the sponge. The gemmules are spherical in shape, have a simple pore tube opening on the upper surface of the bubble cell layer which covers it, and are, when mature, covered by an outer cuticle. They are usually covered by a single layer of perpendicularly arranged birotulates.

In the Australian Museum specimen the gemmules are very abundant, scattered throughout the sponge, are yellowish-brown in colour, and are covered by a single layer of crowded birotulates. They vary from 340 to 442 μ in diameter. They are quite irregular in shape, for, while the prevailing shape is spherical, there

are many flattened gemmules and in a few instances they are so elongated that they become ellipsoidal.

Gemmule Spicules.—The rotules are flat, incised at their borders, either forming small, sharp teeth of nearly equal size, or they may be cut by deeper incisions into larger sectors, which in turn bear upon them smaller and shallower serrations; both of these forms may be found in the same sponge. The teeth are rarely less than twenty in number. In some sponges the rotules are much more deeply incised and form fewer and larger teeth. The rotules vary from 10 to 20 μ in diameter. The shaft is usually smooth, but frequently those with large spines are found. The length of the shaft varies considerably, from 20 to 27 μ, and may, in some sponges, be as much as twice as long as the diameter of the rotule. The shaft is also very variable in thickness, being sometimes very thin, at other times much thicker.

The shaft of the Australian Museum specimen is usually slightly constricted in the centre and becomes larger at each end where it joins the rotule. In most cases the shaft is roughened in the middle area by very minute spines and sometimes it may bear one or more large spines, which at times become almost equal in length to the radius of the rotule. The spicules are of about the same length, varying from 20 to 22 μ. The rotules are shallowly incised, forming sharp teeth.

The rotule varies from 14 to 16 μ in diameter.

Type.—The type is unknown.

Distribution.—This is a very widely distributed species, and has been found in most places over the globe where fresh-water sponges have been studied. No definite location is given for the "*E. haswelli*" from the Australian Museum; it is numbered 333 and marked "Australia" and bears the initials "R.V.L.". Traxler's sponge spicules were found at Geelong, Victoria.

We have a small bit of a sponge (No. 53727) from the Australian Museum with the following notes: "From the side of a boulder in a fresh-water stream at the headquarters of the Woronora River (a tributary of the George's River flowing into Botany Bay), N.S. Wales. Colour in life dark green. The specimens were scraped from a colony of about two square feet. The branching portions of the colony arose from an adhesive flat layer of sponge which entirely covered one portion of the rock anchorage." This sponge was collected by A. A. Livingstone on December 20, 1925.

Unfortunately this specimen contained no gemmules and we were inclined to place it with *E. nigra* on account of the close resemblance in every respect of the skeletal spicules, but after searching carefully through several slides we found a few gemmule spicules, which we illustrate herewith, and these cause us to place this specimen with *E. fluviatilis* for the present. It may, of course, have happened that the few gemmule spicules were introduced from some other source and that this specimen belongs to another species. We hope Mr. Livingstone will collect additional specimens at the same locality when the sponge is bearing gemmules.

E. fluviatilis is a very variable species, as is well shown by the two illustrations given herewith.

Ephydatia kakahuensis Traxler, 1896.

(Figures 12–14.)

Historical Statement.—This sponge was first found by Charles Chilton[42] in Kakahu River, about six miles west of Temuku, New Zealand. It was described and fully illustrated by Traxler[43] in 1896. The same species was also later collected by H. Hill in Lake Taupo, New Zealand, and this find was recorded by Kirkpatrick.[44]

We have two specimens kindly sent us by the Australian Museum of Sydney and marked "*Spongilla*" and one marked "*Ephydatia fluviatilis*" which we believe to be this species, though there are no gemmules present in any of them, and this fact makes positive identification impossible. Two of these were collected by Thos. Steel in Lake Takapuna, Auckland, New Zealand, and the third from a creek near Invercargill, New Zealand. Dr. Arndt has kindly loaned us a slide from the cotype of this species. Our description is based upon Traxler's original one, checked with the materials we have in hand.

Habitat.—The original specimens were collected adhering to sticks or stones in a shallow running stream; one of our bits was taken from a creek, while the others were all taken in lakes. This form seems to grow in either running or still water. Kirkpatrick states that the specimens sent him from Lake Taupo were thoroughly permeated with fine sand.

General Characteristics.—Traxler states that, while we have very little information concerning the form of this sponge, yet it seems to form a crust upon its support and that it has a rather smooth surface, disturbed here and there by the projection of prominent bundles of skeleton spicules.

Kirkpatrick says concerning the specimens sent him: "The specimens had been stranded after a gale. They are about an inch in area and an inch high. Some specimens form thin flat crusts without visible oscules, others are conical, with one large oscule, and others, again, are irregular and meandrine." Chilton stated that: "On stones they formed irregular circular incrustations of a distinct green colour, with the surface tolerably smooth. On the sticks, which were all small, they formed similar masses, sometimes circling right round the sticks."

The small bits in our collection have smooth, irregular surfaces and one piece bears a large osculum opening at the top of a chimney-like structure extending fully one centimetre above the surface of the sponge.

Colour.—The colour is "yellowish-brown in alcohol". Our Lake Takapuna specimens are a very light brown and were evidently taken in very clean water. The bit from the creek is a darker, dirtier brown and contains more sediment than the lake specimen.

Structure.—The texture of the sponge is firm, and even in small bits it can be seen that the entire structure contains numerous comparatively large canals. No very definite main or transverse fibres can be distinguished, since the sponge

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[42] Chilton.—New Zealand Journ. Sci, i, 8, 1883, pp. 383-384. (See also footnote 25, page 33.—Editor, Records of the Australian Museum.)

[43] Traxler.—Termeszetrajzi Füzetek, xix, 1, 1896, pp. 102-104.

[44] Kirkpatrick.—Ann. Mag. Nat. Hist., (9), viii, 1921, pp. 400-401.

is made up of irregular meshes with very thin connections. The amount of spongin is very small.

Skeleton Spicules.—The skeleton spicules are gently curved, rarely straight, cylindrical and of almost uniform diameter until near the ends, where they become abruptly but sharply pointed. They are thickly covered, except on the pointed ends, with small spines rather evenly distributed over the entire surface.

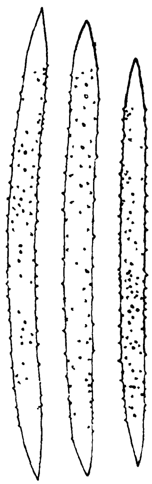

FIGURE 12
Ephydatia kakahuensis
Skeleton spicules

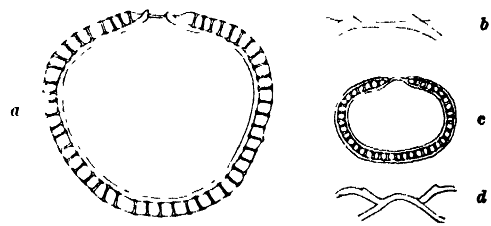

FIGURE 13.
Ephydatia kakahuensis.
a-b, cross-sections through spicule; *c-d*, cross-sections through gemmule of *E. fluviatilis* (after Traxler).

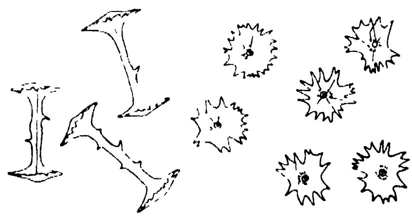

FIGURE 14.
Ephydatia kakahuensis.
Gemmule spicules (after Traxler)

Traxler found them to vary in length from 203–244 μ and in thickness from 8–12 μ. Our measurements of the specimens examined give the following results:

Cotype.	Long	Thick.	
No. 53711	204 - 255 μ	12 - 16 μ	Invercargill, New Zealand
No. 53730	153 - 187 μ	9 - 14 μ	Lake Takapuna, New Zealand
No. 53731	170 - 188 μ	8 - 12 μ	Lake Takapuna, New Zealand
No. 54599	170 - 194 μ	8 - 13 μ	(Indian Mus.) New Zealand

Flesh Spicules.—No flesh spicules are present in this sponge.

Gemmules.—As we have not had access to the gemmules of this sponge we give the substance of Traxler's description of them and the amphidisks.

The gemmules are scattered throughout the meshes of the sponge. They are approximately spherical and have a diameter of 600 μ. The very small air cell layer is 30 to 40 μ in thickness and has no chitinous membrane covering it. The funnel-shaped rim of the pore-tube is smaller than is generally the case in most fresh-water sponges. The air cell layer contains a single layer of amphidisks arranged radially with their proximal disks embedded in the inner chitinous membrane.

Gemmule Spicules.—The disks of the birotulate gemmule spicules are scalloped, the indentations between the scalloped spaces being often equal to half the radius of the disk. The number of pointed projections (teeth) is from 15 to 22. The diameter of the disks varies from 16 to 24 μ, with an average of about 20 μ. The shaft is usually smooth, thick, and often has a bulb-shaped thickening in the middle. Now and then the shaft is supplied with large spines. The length of the amphidisk is from 28 to 45 μ and the thickness of the shaft is 2 to 3 μ.

Type.—We do not know the location of the type of this species, but the Berlin Zoological Museum has a cotype slide which was kindly loaned to us for examination.

Distribution.—Chilton's specimens were taken from Kakahu River, Canterbury, South Island, New Zealand.

Hill's specimens were collected on the north shore of Lake Taupo, North Island, New Zealand. Lake Taupo "is 1,210 feet above sea-level, has an area of 140 square miles and a depth of 300 to 530 feet".

Steel's specimens were collected in Lake Takapuna, near Auckland, New Zealand. Another small bit from a creek near Invercargill, N.Z. (the collector's name is not recorded) is doubtless this same species.

Remarks.—Traxler differentiates *E. kakahuensis* from *E. fluviatilis* by the following characters:

1. The amphidisks of *E. fluviatilis* are more closely crowded around the gemmule.
2. The disks of *E. fluviatilis* seldom reach 25 μ in diameter.
3. The skeleton spicules of *E. fluviatilis* are 200–400 μ long, usually smooth, and, even when spines are present, the general appearance of the spicule is different from that of *E. kakahuensis*.
4. The diameter of the gemmule of *E. fluviatilis* is from 300 to 350 μ.

describe the material which we have in hand at present, and which we consider

5. The pore-tubes of the two species are also different.

He also calls attention to the following points in comparing *E. kakahuensis* with *E. ramsayi*.

1. The skeleton spicules of the two are almost identical.
2. The shafts of the amphidisks of *E. ramsayi* are shorter and thicker than those of *E. kakahuensis*.
3. The gemmules of *E. ramsayi* are of a stronger build and have a smaller diameter than those of *E. kakahuensis*.

Ephydatia lendenfeldi Traxler.

(Figures 15–16.)

Historical Statement.—While examining the alluvial diatomaceous earth of Geelong, Victoria, Traxler found among other sponge spicules thirty large amphidisks which he holds to be those of a new sponge for this region, and which he names *Ephydatia lendenfeldi.*[45]

[45] Traxler.—Földtani Közlöny, xxvi, 1896, pp. 95-97, pl. iii.

Through the kindness of the Australian Museum we have a small bit of a sponge from the Nowra Reservoir, Cambewarra Mountains, New South Wales, which we consider to be the existing form of Traxler's subfossil *E. lendenfeldi.* Since Traxler's description was based upon such limited material we will fully describe the material which we have in hand at present, and which we consider to represent this species.

Habitat.—Our small specimen was found "growing amongst stems of *Plumatella*" in the Nowra Reservoir.

General Characteristics.—The specimen we have is too small to give us any definite idea of the habit of growth of the sponge. The small bits give no indication whatever of the size or extent of the sponge and the note accompanying it simply gives the locality from which it was collected.

Colour.—The specimen is light brown in colour.

Structure.—The sponge seems to be made up of irregular meshes without any very definite radial or transverse rays. These meshes have sides of about the length of the skeleton spicules.

Skeleton Spicules.—The skeleton spicules are generally slightly curved, rarely straight, covered, except near their ends, with small spines. The spines vary a great deal in number; at times spicules may be found which are almost free of

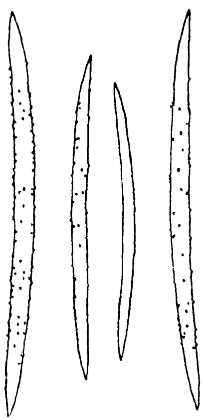

FIGURE 15.
Ephydatia lendenfeldi.
Skeleton spicules.

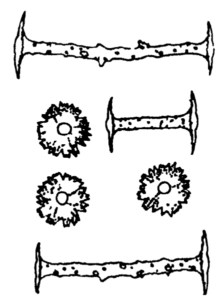

FIGURE 16.
Ephydatia lendenfeldi
Gemmule spicules.

them, while others may be very thickly covered with them. Some of the spicules are typically spindle-shaped, being thickest in the centre and gradually tapering from that point to very fine points at the ends; in spicules of this kind the spines are more crowded at the centre and often the ends are entirely smooth. The other skeleton spicules, which are much more numerous, are also thickest at the centre, but taper very gradually to near the ends, where they abruptly become sharp-pointed; some of the smaller ones are more cylindrical, becoming abruptly pointed. These spicules vary a good deal in length, from about 287 μ to 382 μ, the

average being around 340 to 360 μ. They are from 10 to 19 μ in thickness, the average being around 13 to 15 μ.

Gemmules.—The gemmules are light brown in colour, spherical in shape, flattened a bit when dry, are not bound together as in *S. fragilis*, though they are crowded into groups, not in layers, in the basal portion of the sponge. They seem to be very numerous, as our small specimen bears a comparatively large number of them. They are covered by a single layer of gemmule spicules of varying lengths, arranged perpendicularly to the surface of the gemmule, and embedded in a granular coat covering the whole structure. The pore-tube is simple and has a circular opening just below the outer surface of the granular layer. The gemmules vary somewhat in diameter, from around 493 μ to 561 μ.

Gemmule Spicules.—The gemmule spicules are also very variable in length; some of them are quite short, measuring only about 30 μ in length, while the longest ones are as much as 80 μ long. Lendenfeld's measurements ranged from 35 to 73 μ in length, so our form corresponds very closely in this respect with the one studied by him.

The cylindrical shaft of the spicules is roughened by granules or very fine spines; only an occasional shaft bears one or two long spines. While the shaft is straight in the larger number of cases, yet very often, especially in the longer forms, it is slightly curved.

We find that in most cases the outer and inner rotules differ a little in diameter; this is especially true in the shorter, straight-shafted spicules. The longer shafted ones seem to bear more nearly equal rotules, but here, too, are sometimes found inequalities in size.

The rotules are flat and bear numerous very fine, shallow indentations with very sharp teeth; at times there may be larger lobes made by larger shallow incisions and these lobes bear the fine teeth. The surface of the rotules is covered, especially near the outer edges, with very fine granulations, and these often extend in radial lines from the base of the shaft to the outer edges of the rotule. We find the smaller rotules to vary from 17 to 22 μ in diameter, while the larger ones are from 20 to 24 μ across.

Type.—Lendenfeld does not record the location of the type.

Distribution.—This species was originally described as subfossil from the diatomaceous earth of Geelong, Victoria. Our specimen was collected by Dr. F. A. Rodway in the Nowra Reservoir in the Cambewarra Mountains, New South Wales. If we are correct in our determination of this form it is still to be found as a living form, and it is so similar in all respects to the one described by Lendenfeld that we do not feel justified, without examining his type, in even making it a variety of his species.

Remarks.—There are two other sponges which we would place in this species for the present. One is a very small specimen from Waneroo Lake, near Perth, Western Australia, kindly sent to us by Professor G. E. Nicholls. The specimen was collected on April 7, 1923.

The other is a small specimen, torn into small bits, collected by Mr. D. N. Johns from a water pipe connected with a pump at Ungarie, New South Wales. This specimen was sent to the Australian Museum by Mr. E. Cheel, of the Botanic Gardens, Sydney, with a letter dated April 15, 1928.

Ephydatia multidentata (Weltner), 1895.

(Figures 17–18.)

Historical Statement.—Weltner first described this species in his "Spongilliden-studien III."[46] The sponge had been collected by Semon in the Burnett River in Queensland, Australia, and was first placed in the genus *Tubella* by Weltner, but, writing later,[47] he redescribes this species in much detail and gives as his reason for changing its generic classification from *Tubella* to *Ephydatia* that there is so little difference in the size of the rotules. We follow Weltner's very full description.

Habitat.—From the appearance of the under portion of the sponge Weltner judged that it had been taken from the surface of a piece of wood which was covered by the water of the river.

General Characteristics.—Weltner had only two small pieces of the sponge which measured about five and a half centimetres long and about one-half centimetre thick. He says that the upper surface of his specimens was uneven and contained a number of small and larger holes. The larger ones were considered to be excurrent oscula, while the smaller ones were thought to be the canals through which the water entered the sponge. The bubble cells so characteristic of *E. mulleri* are also common in this sponge.

The small bit of this sponge kindly given us by the Australian Museum contains one large osculum opening on an apparently smooth surface.

Colour.—The specimens examined by Weltner were described as "yellowish and dark grey" in colour Our small specimen, a cotype secured from the Berlin Museum through the kindness of Dr. Arndt, is of a dark brown colour. The other small specimen from the Australian Museum is a light yellowish-brown or straw colour.

Structure.—The lower part of the sponge skeleton is made up of an irregular network of skeleton fibres, but a more definite arrangement into perpendicular and transverse fibres is found in its upper portion. The number of spicules in the fibres is very variable and Weltner counted as many as twelve making up most of them. The main and the transverse fibres are of about equal size, and where more or less regular meshes are formed they measure from 175 to 350 μ across

Skeleton Spicules.—There is very great variation in the skeleton spicules of this sponge. The larger number of spicules are slightly curved, spindle-shaped, with rather abruptly but sharply pointed ends, and bear a varying number of very fine spines. There are a few exceptions to all of these characters; straight spicules may be found, at times one or both ends of the spicules may be rounded, and it is not unusual to find now and then a perfectly smooth skeleton spicule in our preparations. The spines vary from a very few to very large numbers, but, as a rule, are not found near the ends of the spicules. The axial channel is frequently clearly visible in these spicules. Weltner gives the following dimensions of the spicules:

Length	270 to 390 μ	Average around ..	340 μ
Thickness .	15 to 20 μ	Average around ..	18 μ

[46] Weltner —Archiv für Naturg , i, 1895, pp. 142-143.

[47] Weltner.—*In* Semon's Zoologisch. Forschungsr., v, 5 (Denkschr. Medic. Naturw. Ges., Jena, viii), 1900, pp. 519-523.

Our measurements of the length of these spicules of our cotype correspond to these in the main, but possibly even a little wider range would be necessary to cover the great variations; we find the thicker ones to measure as much as 24 μ in diameter.

Flesh Spicules.—No flesh spicules have been observed. Small, slender, mostly smooth spicules are found throughout the preparations; these should not be confused with flesh spicules as they are young skeleton spicules.

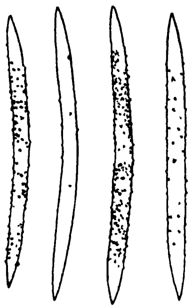

FIGURE 17.
Ephydatia multidentata
Gemmule spicules

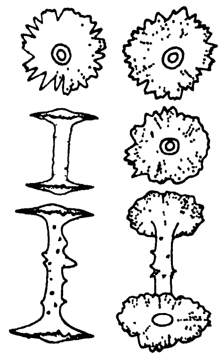

FIGURE 18
Ephydatia multidentata
Skeleton spicules

Gemmules.—The gemmules are numerous and are at the base of the sponge in one or more layers. They are from 500 to 650 μ and average around 560 μ in diameter, spherical or oval shaped and a light brown in colour. The pore-tube is simple and does not project beyond the layer of protective material which covers the gemmule. The air cell layer covering the gemmule is of very variable thickness; in places it may be just thick enough to barely cover the single layer of gemmule spicules or amphidisks; at other places even on the same gemmule the development of the bubble cells may make this layer three or four times as thick as the thinner area. For this reason these gemmules generally present a very uneven surface.

Weltner calls attention to the fact that these air cells often develop to the extent of uniting several gemmules together, but that they do not form characteristic gemmule groups as is the case with *Spongilla fragilis.* He also observed that, while as a rule there was only a single layer of gemmule spicules around the gemmule, yet in many cases he found single amphidisks of a second lying embedded in the bubble cells. The air cell layer varies from 30 to 120 μ in thickness.

Gemmule Spicules.—The length of the amphidisks varies greatly, the longest ones being at least twice the length of the shortest ones. The shaft is of a uniform diameter throughout its length and is covered with small spines and granulations; now and then a few large bluntly pointed spines or cones are also present. The disks, or rotules, are also covered by the fine spines and small tubercles which

are often arranged in rows radiating from the centre. The disks are biconvex and their edges are very finely and irregularly incised. The disks are of nearly the same size, though the outer ones average a bit smaller.

Weltner gives an interesting lot of illustrations showing how these spicules develop. He gives the following measurements:

Length of shaft	28 to 56 μ
Thickness of shaft	4 μ
Diameter of inner disk . . .	22 to 26 μ
Diameter of outer disk .	20 to 22 μ

Our measurements of these spicules confirm the figures given by Weltner.

Type.—The type of this sponge is preserved in the Berlin Museum. We have a minute cotype in our collection.

Distribution.—So far this sponge has been found in the original locality, Burnett River, Queensland, where it was collected by R. Semon, and a small specimen collected in Cooper's Creek, in south Central Australia. This latter specimen is a small bit of a sponge kindly sent us some time ago by the Australian Museum.

Remarks.—For a very full discussion of the canal system and the histology of this sponge the reader is referred to Weltner's paper of 1900 mentioned in the first paragraph of this description.

We have a small bit of sponge from Cooper's Creek, sent us some time ago by the Australian Museum, which we assign to this species. It is lighter brown and more yellowish than the tiny specimen given us by the Berlin Zoological Museum. The skeleton spicules are shorter and thinner than those in Weltner's specimen; our measurements are: length 221 to 316 μ, and thickness 14 to 17 μ. Otherwise they correspond to those of the ones described by Weltner. Our measurement of the rotules of the gemmule spicules of the Cooper Creek specimen are exactly the same as Weltner's, but we find the length of the shaft to vary less—from 26 to 42 μ.

Ephydatia multiformis Weltner, 1910.

(Figures 19-23.)

Historical Statement.—The Michaelsen and Hartmeyer expedition to study the fauna of south-west Australia collected one fresh-water sponge in Herdsman's Lake, near Subiaco, in 1905. Weltner described and illustrated this as a new species, *E. multiformis*.[48] Since we have not seen a large piece of this sponge, our brief description is condensed from a translation of Weltner's very full one given in the reference above and checked by our observations upon the spicules.

Through the kindness of Dr. Arndt, of the University Zoological Museum, Berlin, we have a tiny bit of this sponge and have a slide prepared from this. We also have a small bit of sponge representing this species which was furnished us by the Indian Museum. It is recorded as an exchange from the Australian Museum and was collected at Toronto, Lake Macquarie, New South Wales.

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[48] Weltner.—*In* Michaelsen und Hartmeyer, Die Fauna Südwest-Australiens, 1910, pp. 137-144.

Habitat.—The sponge was found forming thin crusts on bark and pieces of wood in the lake.

General Characteristics.—It was small and thin, the crusts being about 3 cm. long and above 3 mm. thick and of delicate consistency. The upper surface is smooth; branches and projections are lacking, but it is not determined as yet whether or not these are present in larger specimens of the sponge. Through the epidermis the large openings of the incurrent canals can be readily recognized even with the naked eyes.

Colour.—In alcohol the colour is grey. According to the collector's notes the pieces of the sponge were pale yellowish-grey when they were fresh.

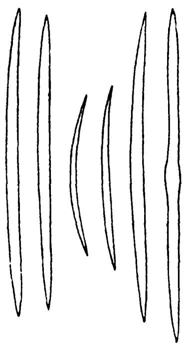

FIGURE 19.
Ephydatia multiformis.
Skeleton spicules.

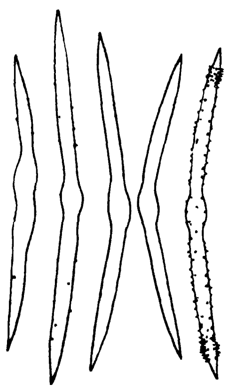

FIGURE 20
? *Ephydatia multiformis.*
Skeleton spicules bearing bulbs

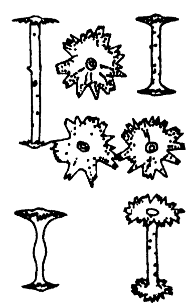

FIGURE 21.
Ephydatia multiformis.
Skeleton spicules

Structure.—The solid skeleton consists of slender longitudinal fibres which stand perpendicularly to the stratum. These fibres are separated from each other at intervals of about the length of a spicule and are united together by transverse spicule-bridges. The longitudinal fibres are composed of single spicules lying one behind the other, or of bundles of from two to four spicules lying closely against one another; both of these arrangements may appear in the same fibre. The transverse fibres are usually thin and consist of one to two spicules. Between the two kinds of fibres there are many other irregularly scattered spicules which resemble those of the solid skeleton. In many cases even the entire skeleton is composed of only the irregularly entangled spicules.

The amount of spongin is small and in an unstained specimen can be distinctly seen only at the points of contact between the spicules.

Skeleton Spicules.—The skeleton spicules are of only one type; they are slender, smooth, usually slightly curved, gradually sharp pointed axials, which show various sizes. The larger ones range from 344 to 425 μ in length and from 13 to 20 μ in thickness, averaging around 374 μ long and 16·6 μ thick. The variations in thickness do not always correspond with the length, for often a short spicule may be as thick as the longest ones.

Weltner found a very great variation in the size of the spicules, some being as small as 104 μ long and 3 μ thick, and from that size all the way up to the greatest length, 425 μ.

Flesh Spicules.—Now and again in the slides of the spicules which we have examined, we find among the smaller spicules those around 200 μ in length, which are covered with small spines. They are 7 or 8 μ in thickness and doubtless are the parenchyma spicules to which Weltner calls attention in his description of this species in 1910. These are very similar to the smaller spicules illustrated herewith, except that they bear spines.

Gemmules.—The gemmules lie loosely in the meshes of the skeleton in the basal portion of the sponge without being surrounded by a common air-chamber-layer; they may be easily separated from the sponge or its substratum.

They are yellowish in colour, round or oval-shaped and of different sizes.

In most of the gemmules examined by Weltner the contents had already been discharged and he concluded that the sponge examined was the product of the empty gemmules.

The pore-tube represents a short elongation of the inner cuticule covering the gemmule and it does not extend beyond the upper surface of the layer surrounding the gemmule, but is somewhat sunken in like a navel. There are 9 to 11 birotulates surrounding the pore-tube. The gemmule is surrounded by a single layer of radially arranged gemmule spicules which lie in the air cell layer. The gemmules were found to vary from 500 to 750 μ in diameter.

Gemmule Spicules.—The birotulates have unequal disks and vary considerably in length. Weltner's descriptions of the differences of the structure of the disks is limited to the basal disk. He describes several types as follows:

1. The disks are mostly star-like in which the disk is divided into teeth and lobes formed by deep incisions; often the depth of these deep incisions is up to one-half or more of the radius of the disk. The lobed areas themselves are unindented. The teeth are quite similar in size and are seldom blunt at the ends. The number of teeth and lobes varies from 10 to 30. The diameter of the disk varies from 12 to 20 μ. The shaft is smooth. The figures from Weltner show two varieties of this group of disks. one with shallow and the other with deeper incisions.

2. Sometimes from the same gemmule one will find birotulates with the disks irregularly and coarsely lobed; the single lobes are usually separated by shallow notches and the lobes are unindented or appear as if they had been gnawed or very finely toothed.

3. Other disks show a large number of smaller finely toothed lobes.

4. Others show a combination of finely toothed lobes and larger pointed teeth.

5. Still other disks show unindented or toothed lobes between which are larger teeth, but the lobes, the teeth and the surface of the disks are made rough or granular by very fine spines. The shaft of these amphidisks is smooth, or finely roughened or granular, or with single larger spines.

The longest amphidisks were 44 μ long and others as short as 24 μ. The basal disks varied from 14 to 24 μ and the distal ones from 14 to 18 μ. The diameter of the shaft was as great in the shorter amphidisks as in the larger ones, varying from 2 to 4 μ.

Type.—The type of the sponge is in the Berlin Zoological Museum.

Distribution.—It has, up to the present, been reported from only one place, the type locality, Station 111, Herdsman's Lake, near Subiaco, south Western Australia, Sept. 3, 1905.

Remarks.—Professor G. E. Nicholls sent me another small sponge (No. 53695) collected at Two People Bay Pumping Station, near Albany, Western Australia, which is unique in that both the skeleton and the gemmule spicules invariably have the central portion of their shafts enlarged into bulbs.

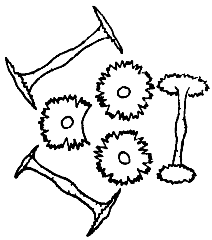

FIGURE 22.
? *Ephydatia multiformis.*
Gemmule spicules with bulbs

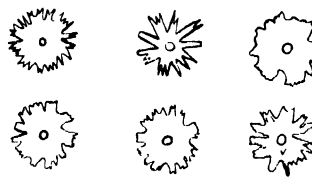

FIGURE 23
Ephydatia multiformis
Ends of rotules (after Weltner).

The skeleton spicules vary from common altogether smooth ones characteristic of *E. multiformis* to those rare ones spined as shown in our illustration. These spicules range from 245–302 μ in length, and from about 10–16 μ in thickness.

The gemmule spicules average somewhat longer than those of the specimen from Herdsman's Lake and are less variable. Most of them are from 41–48 μ in length and the outer rotules are from 16–21 μ in diameter, while the inner ones are slightly larger, being usually about 22 μ in diameter. The difference in diameter of the rotules is at times quite marked, while in other cases the two rotules may be about equal.

We place this sponge in this species tentatively. It may be that we have just an abnormal specimen, but the very fact that it is rare that we find even one spicule free from the bulb would seem to entitle it to at least a varietal name which should be *bulbosa*. We will await further material from that locality before creating a new variety.

Our illustration shows the characteristics described above.

Ephydatia nigra (Lendenfeld).
Tubella nigra Lendenfeld, 1887.
(Figures 24–26.)

Historical Statement.—This sponge was first found in the neighbourhood of Sydney and later also in Victoria (no definite locality was named by Lendenfeld).

The author of the species described it as a new species and illustrated it.[49] Weber,[50] in enumerating the sponges from the Dutch East Indies, mentions *T. nigra* as having been found in Borneo, but we take this to be an error, as he was doubtless referring to *T. vesparium*.

Through the courtesy of the Australian Museum we have been allowed to examine the type of this species which was collected in Moore Park, Sydney. Our description is based upon the original one of Lendenfeld checked by our observation of preparations from the type. The drawings are made from the type.

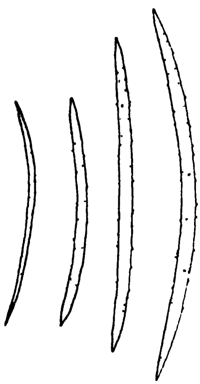

FIGURE 24.
Ephydatia nigra
Skeleton spicules

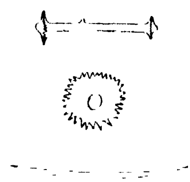

FIGURE 25.
Ephydatia nigra.
Spicules (after Lendenfeld).

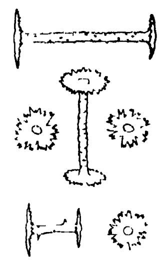

FIGURE 26
Ephydatia nigra.
Gemmule spicules

Habitat.—Of the two localities from which the sponge was collected, one was a swamp and the other was a pond. In both cases the sponge was doubtless found in standing water.

General Characteristics.—*E. nigra* forms thin crusts from 2 to 5 mm. thick upon its support and has a smooth velvet-like surface. The sponge often spreads out horizontally over an area of as much as 70 mm. long by 50 mm. wide and has an uneven, irregularly lobed margin There are several small bits in the type specimen, no pieces so large as the one mentioned above. Some of the sponge in the type material is growing with a bryozoan, probably *Plumatella*, the two being thoroughly interwoven with each other.

Colour.—The crusts are blackish in colour. Whitelegge states[51] that "this species is not naturally black as the name would imply; the specimen described was stained with black mud, the true colour being a dirty yellow."

Structure.—The sponge is very soft and the canals are small and inconspicuous. The spicule bundles which form the skeleton fibres are very slender and fragile and are often made up of a line of single spicules.

49 Lendenfeld — Zool. Jahrb, ii, 1887, p. 91.
50 Weber — Zoolog. Ergebn. Niederl Ost-Indien, 1890, p. 46.
51 Whitelegge — Journ. and Proc, Roy Soc. N S W, xxiii, 1889, p. 306.

Skeleton Spicules.—Lendenfeld describes the skeleton spicules as being decidedly spindle-shaped, gradually and sharply pointed, slightly curved and absolutely smooth. He gives their length as being 220 μ and their diameter as 7·4 μ in the centre of the spicules.

Our observation of preparations from the type do not altogether agree with the above. We find the skeleton spicules to be generally decidedly curved, but with a few rare straight ones. Instead of being smooth they are covered with very fine spines except at their sharpened tips; the degree of spininess varies considerably, but none of the spicules are smooth. The prevailing kind of spicule is cylindrical, of about uniform diameter, with rather abruptly sharpened ends. Our measurements correspond fairly well with Lendenfeld's, the spicules varying from 212 to 248 μ in length and from 6 to 9 μ in thickness. It is possible that Lendenfeld examined the spicules with only a low power lens and overlooked the fine spines.

Flesh Spicules.—We find no flesh spicules in this species.

Gemmules.—Lendenfeld observed that the gemmules formed a continuous layer at the base of the sponge; that they were irregular, spherical, and covered with a single layer of birotulates; that they measured about 300 μ in diameter.

We find the gemmules very numerous and crowded throughout the entire thin crust of the sponge, but without a distinct clearly arranged single layer at the base of the sponge as illustrated by Lendenfeld. They are irregularly spherical, often somewhat flattened, have a simple pore-tube opening on the surface of the protective layer of the gemmule, which is composed of a single layer of birotulates embedded in a granular layer. The diameter of the gemmules varies a good deal, from 382 to 450 μ in those measured by us.

Gemmule Spicules.—Lendenfeld describes these spicules as follows: They are amphidisks, 33 μ in length; the slender shaft, 1·5 μ in diameter, bears a few sharp slender spines, which in the centre of the shaft at times reach a length equal to the diameter of the smaller rotule. The disks or rotules are regularly incised like a spur wheel with many teeth of equal size. The outer ends of the shaft project slightly beyond the rotules at each end. The diameter of the larger rotule is 12·5 μ and that of the smaller one is 8 μ, otherwise the rotules at both ends are altogether similar.

In the type specimen from the Australian Museum there are certain decided differences from the form described above by Lendenfeld. We find (slide No. 54524) very marked variations in the length of the shaft of the spicules, from 30 to 68 μ in length. The rotules are also variable; in some cases the two of the same birotulate spicule are very nearly of equal diameter; in others their difference in size is as much as 5–7 μ. We also found the rotules to be considerably larger than those recorded by Lendenfeld. Our measurements of three typical birotulates gave the following results:

Smaller disks	16 μ	17 μ	14 μ
Larger disks	18 μ	20 μ	20 μ

The shafts are usually granular or provided with very minute spines, they are rarely altogether smooth; now and then a single long thin spine, rarely

equal to the radius of the smaller rotule, is found near the central portion of the shaft. The shorter birotulates as a rule have straight shafts, but the longer ones are frequently slightly curved. The disks vary a good deal, some are provided with numerous small, sharp teeth, the incisions often being equal to nearly half the radius of the disk; the teeth frequently have very fine granulations near their outer tips. Others have shallower incisions, finer teeth, or may even be divided into lobes with small teeth. The shaft forms only a low, rounded projection on the outside of the disk.

Type.—The type is preserved in the Australian Museum, Sydney.

Distribution.—The following are the records of the occurrence of this sponge to date: by Lendenfeld in 1887—(1) from a swamp near Sydney, (2) from a pond, with no definite locality given, in Victoria; by Whitelegge in 1889—(3) from a pond in Moore Park, Sydney (this pond was already filled in at the date given), (4) from Wooli Creek, Cook's River, Sydney. Weber in 1890 records it from Borneo, but I take this to be intended for *T. vesparium.*

Remarks.—The difference between the sponge described by Lendenfeld as *Tubella nigra* and the specimen marked as the *type* of this species in the collection of the Australian Museum raise the question whether or not these are two separate and distinct sponges. It might help to solve the difficulty if fresh gemmule-bearing material could be secured from as many of the localities given as now have sponges growing in them.

We would also give the sponge from the Australian Museum marked as the *type* of this species the generic name of *Ephydatia* instead of *Tubella*, since the rotules are often of about the same size and are both characteristically *Ephydatia*-like, though at times they differ a good deal in size.

For the sake of comparison we also reproduce Lendenfeld's drawings of his *T. nigra.*

Ephydatia ramsayi Haswell, 1883.

(Figures 27–28.)

E. fluviatilis var. *ramsayi* Haswell-Lendenfeld, 1887.

Historical Statement.—*Meyenia ramsayi* was first found by E. P. Ramsay in the Bell River at Wellington and described as a new species by Haswell[53] in 1883. This sponge was later found again by Lendenfeld in 1887 and 1888 in Macquarie River, near Dubbo, in New South Wales, and described by him.[58] Through the kindness of the authorities of the Australian Museum I have been allowed to examine the type of this species, and the following description is based upon the combined result of these references and my own observations.

Habitat.—Haswell states that it is a "rather deep growing species" and that it was found "growing in considerable masses attached to submerged timber".

Lendenfeld states that it was found growing on submerged branches which it completely covered.

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[53] Haswell.—Proc. Linn. Soc. N.S.W., vii, 1883, p. 210.
[58] Lendenfeld.—Zool. Jahrb., ii, 1887, pp. 92-93.

General Characteristics.—Haswell says: "Sponge massive, tubercular, or with finger-like projections." Lendenfeld states that "the sponge is massive with irregular ripply surface; it covers its support for 50 mm., and reaches a thickness of 30 mm.; it is sometimes more massive on one side of the support and covers only one side of the supporting branch. Single oscules are visible on the surface of the sponge."

The type consists of two small pieces, presents a smooth surface, and is permeated by numerous small canals. It shows the effect of having been pressed in the packing. One piece begins as a thin film surrounding a small stick and reaches a thickness of about one centimetre at the other end, where it appears that the stick upon which it was growing was broken off with a portion of the sponge. The other piece is on a stick of about the same size, possibly a part of the same stick; it is about 6 cm. long, the sponge forming a mere film on one side and reaching a maximum thickness of two and one-half centimetres on the other side of the support.

Colour.—The type in alcohol is a dirty brown in colour and contains a large amount of sediment in it. Colour of the fresh sponge is "grass green to greyish-yellow", according to Haswell. Lendenfeld says that when alive this sponge is light brown or dirty yellow in colour.

Structure.—Lendenfeld states that the consistency of the sponge is massive and hard: the skeleton is composed of the usual skeleton bundles: the canals are noticeably wide and thereby impart to the sponge a very lacunar character.

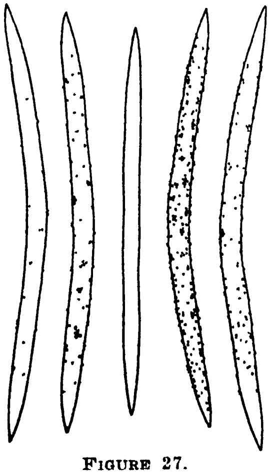

FIGURE 27.
Ephydatia ramsayi
Skeleton spicules.

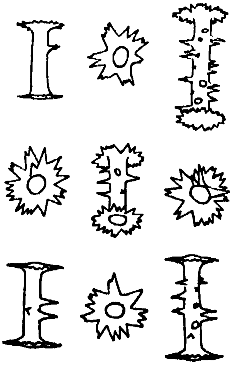

FIGURE 28.
Ephydatia ramsayi.
Gemmule spicules.

We find it difficult to detect any definite main or transverse fibres in the type specimen, the sponge being made up of a mass of irregularly arranged meshes bounded by thin walls composed of only very few spicules.

Skeleton Spicules.—Haswell thus recorded his observations: "Skeleton spicules curved, fusiform, rather abruptly acute, perfectly smooth." Lendenfeld says that they are not so definitely spindle-shaped as are those of some forms of *Ephydatia*

fluviatilis, but are more cylindrical and suddenly pointed. He finds the surface slightly spiny. He measured them as being 220 μ long and 10 μ thick.

Our observations based upon preparations from the type are as follows. The spicules are slightly curved, while some few of them are smooth, yet most of them are covered, except at their ends, with very fine spines which Haswell must have overlooked. Our drawings show these spines a little too heavy. The spicules are varied in shape, some of them being cylindrical with abruptly formed sharp points; others are largest near the centre, some few even being bulbous there, and gradually taper to very fine points at their tips. We find them to average considerably larger than Lendenfeld's measurements; the spicules range from 246 to 340 μ in length and from 10 to 16 μ in thickness. It is rare that one finds one as short as 220 μ in length.

Flesh Spicules.—No flesh spicules are present in this species.

Gemmules.—Most of the gemmules in the type are located in the basal portion of the sponge, though a few are scattered singly through the mass and now and then occur near the surface of the sponge. They are numerous, and, while they are usually crowded close together, there is no regularity in their arrangement. They are spherical in shape and are covered by a single layer of regularly arranged birotulates. We find them to vary in diameter from 357 to 450 μ. The average is somewhat larger than that given by Lendenfeld as 350 μ.

Gemmule Spicules.—Haswell states that the birotulate spicules "consist of a stout cylindrical shaft armed with 1 to 10 acute and prominent spines, and terminal rotulæ the edges of which are deeply dentate or spinous, the teeth—to the number of between 12 and 20—being irregular in size and acute".

Lendenfeld finds the number of teeth to vary between 12 and 16 and our count gives between 16 and 22. The number is very variable and has, we think, no specific significance. Lendenfeld finds the length of the gemmule spicule to be 29 μ and the shaft to have a diameter of 4·8 μ, while the diameter of the rotule is 20 μ.

Here again our measurements of the type birotulates show a somewhat larger structure with the following dimensions: length, 32 to 42 μ; diameter of rotule, 20 to 22 μ, and diameter of shaft 5 to 6 μ. The spines on the shaft of the spicule vary from very short ones to almost as long as the radius of the rotule itself. We found the number of spines to range from 0 in a very few cases to as many as 14 in others.

Type.—The type is preserved in the Australian Museum.

Distribution.—This species has been found in Bell River at Wellington and in Macquarie River, near Dubbo, New South Wales. Chapman, in 1922, also reports it from Tintenbar, Richmond River, New South Wales, as found in opal nodules. Weltner (1900) states that two local forms of this sponge are known in South America also, one in Argentine and another in Paraguay. Annandale describes[54] a specimen sent to him by Professor Max Weber as this species. It was collected growing upon the shells of living snails in a small stream at Sekanto, near Humboldt Bay, by the Dutch New Guinea Expedition, on May 30, 1903.

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[54] Annandale—Nova Guinea, v. 3, 1909, p. 421.

Remarks.—There has been a good deal of difference in opinion as to whether this sponge is entitled to specific rank. Lendenfeld and later Annandale have made it simply a variety of *E. fluviatilis.* Haswell gave it specific rank, and Weltner has contended strongly and persistently that the characters of both the skeleton and the gemmule spicules were distinct enough to entitle the sponge to specific rank. We hold with Weltner, for, while such forms as *E. meyeni* are separated as species from *E. fluviatilis*, *E. ramsayi* is much more entitled to be so separated.

Since Lendenfeld's measurements differ so much from our measurements of the type specimen of this sponge, we wonder if he had specimens of the same sponge for examination.

Three Sponges without Gemmules.

In addition to the foregoing sponges which we have described, we also have small specimens of the following three sponges:

(1) One received from Mr. E. W. Bennett, M.Sc., which was collected at Tandakot, Western Australia. This was labelled: "? *Ephydatia*".

(2) Another sent us by the Australian Museum which was collected at Legges' Camp, Myall Lakes, near Port Stephens, New South Wales.

(3) A third from Lake Sarah, Cass, New Zealand, marked: "*Spongilla fluviatilis*".

We can find no gemmules or gemmule spicules in any of these, and therefore hesitate to place them in any classification. Possibly the collectors of these specimens may be able to collect gemmule-bearing specimens at a later date, and then definite determinations can be made.

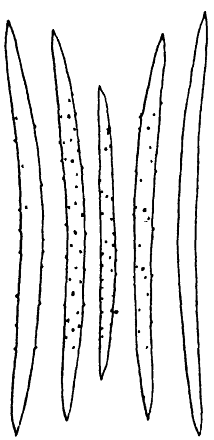

Figure 29.
Skeleton spicules of sponge from Tandakot, Western Australia.

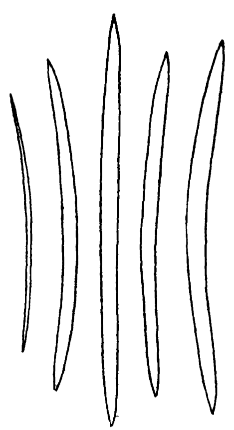

Figure 30.
Skeleton spicules of sponge from Legges' Camp, near Port Stephens, New South Wales.

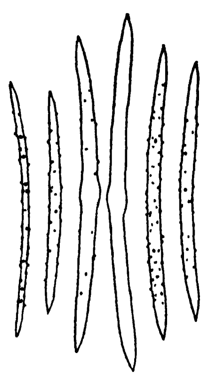

Figure 31.
Skeleton spicules of sponge from Lake Sarah, Cass, New Zealand.

DESCRIPTIONS AND RECORDS OF FULGOROIDEA FROM AUSTRALIA AND THE SOUTH PACIFIC ISLANDS. No. I.

By

F. MUIR,

Warnham, Sussex, England.

The material dealt with in the following paper forms part of three lots of material submitted to me for identification; first, a collection belonging to the Australian Museum, Sydney; second, material belonging to the British Museum (Natural History) and, third, a small collection made by Dr. P. A. Buxton.

The Polynesian area presents some interesting problems in distribution. An expedition from Honolulu is at present at work in the eastern portion of this area. The line of migration has been largely from west to east, as the insect fauna gets poorer as we proceed east. Our knowledge of the insect fauna of the richer western islands is very meagre and records from that area will be of interest for comparison with Samoa and further east. The proximity of these islands to Australia and the comparatively easy access to them should make the problem of their insect fauna of particular interest to Australian entomologists. To build up a collection from these islands should be the ambition of at least one Australian museum.

CIXIIDÆ.

Aka tasmani sp. n.

(Fig. 1.)

♂. Length, 3·8 mm.; tegmen, 3·3 mm.

No spines on the hind tibiæ; the two median frontal carinæ near together, distinct till near the apex. The width of vertex at base a little greater than the length in the middle; the median longitudinal *Y* carina distinct only on the base, the fork missing. The five carinæ on mesothorax distinct. The *Sc* + *R* forking near base, the *Cu* fork about middle, all veins unbranched, except the tip of Cu_{1a}. The texture of head, nota and tegmina between veins finely rugose.

Dark brown; lighter over carinæ and in middle of pronotum. Tegmina light brown, veins darker; basal half of costa light, three or four lighter marks on apical half of costal margin. Legs light banded with slightly darker marks.

The anal segment truncate at apex and produced into a short, triangular spine at each apical corner. The three spines at apex of periandrium differ from those

of *A. finitima* (Walker), and the genital styles are distinct, but the affinity of these two species is evident.

♀. Length, 4 mm.; tegmen, 3·3 mm.

Pygofer wider than long, ovipositor complete, reaching beyond the anal segment. In build and colour similar to male, but inclined to be darker.

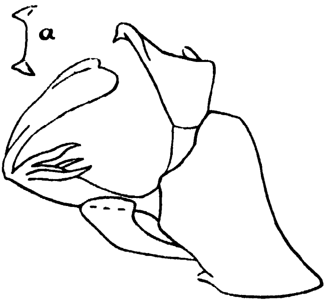

FIGURE 1.—*Aka tasmani*, lateral view of male genitalia; *a*, apex of anal segment

Locality.—Described from four ♂ and two ♀ from Hobart, Tasmania (G. H. Hardy, May, July, 1913). There is one large ♀ (length 5·2, tegmen 4 mm.) from the same locality, which appears to be the same species.

Type.—Type in Australian Museum, paratype in British Museum (Natural History).

Aka hardyi sp. n.

♂. Length, 3·8 mm.; tegmen, 3·3 mm.

Vertex shorter than in *A. tasmani*; the areolets reaching nearly to the base; the medio-lateral carinæ of mesonotum very indistinct. The rugose surface of head, nota and tegmina similar to *A. tasmani*. The apex of the anal segment is round, not produced, without any spines; the genital styles are more rounded at the apex.

Dark brown, the carinæ slightly lighter. Tegmina light brown, veins slightly darker, *Sc* and *R* more so; a few darker marks on costa, over the apical veins and in the middle of corium; a dark mark on margin beyond clavus. Legs, thoracic pleura, the pygofer and genital styles light.

Locality.—One ♂ from Mount Wellington, Tasmania (G. H. Hardy, 30th September, 1917).

This genus has hitherto been represented by one species from New Zealand. It is interesting to get these two distinct species from Tasmania which are quite typical of the genus.

Type.—Type in Australian Museum, Sydney.

Oliarus doddi sp. n.

(Fig. 2.)

♀. Length, 4 mm.; tegmen, 5 mm.

Width of vertex at base about equal to length in middle, apex narrower than base, narrowing more rapidly from middle, areolets reaching back to middle,

narrowly triangular, base angularly emarginate, apex slightly rounded. Median frontal carina with a minute fork at base. First claval vein joining second one-third from its base (measuring the second from where it leaves the scutellar margin), *Cu* forking slightly distad of middle of corium, *Sc* + *R* very slightly more distad, *M* at nodal line.

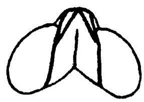

FIGURE 2.
Oliarus doddi, dorsal view of head.

Frons light brown with dark marks on each side of carina at apex; vertex dark brown. Pronotum light brown or yellow, darker brown in middle and on lateral margins. Mesonotum reddish-brown, dark brown between the middle and medio-lateral carinæ and anteriorly, also on the anterior and middle portion of lateral areas. Tegulæ yellow. Coxæ and femora dark brown, tibiæ and tarsi yellow. Abdomen brown with the basal tergites light. Tegmina hyaline, slightly opaquely white, a dark brown mark across base, a dark mark on commissure at apex, which extends as a faint fuscous mark partly across tegmen, a dark mark over nodal line, stigma yellow on outer margin, otherwise dark brown, apical cross veins dark brown, extending slightly into cells; apices of apical veins brown, other veins same colour as cells. Wings hyaline with dark veins.

Locality.—One ♀ specimen from Townsville, Queensland (F. P. Dodd, 24th October, 1903.

Type.—Type in the British Museum (Natural History).

Oliarus hackeri sp. n.

(Figs. 3 and 4.)

♂. Length, 5·4 mm.; tegmen, 5·8 mm.

Length of vertex in middle very slightly greater than width at base, apex slightly rounded, base deeply, roundly emarginate; areolets small, nearly square, about one-sixth the length of sides of vertex, in normal dorsal view not all visible (figure drawn with apex turned up to show areolets). First claval vein joining second one-third from its base; *Cu* forking near middle of corium, *Sc* + *R* near to nodal line, *M* at nodal line.

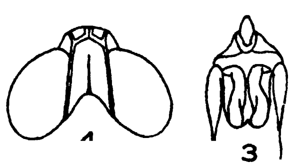

FIGURE 3.—*Oliarus hackeri*, ventral view of male genitalia.
FIGURE 4.—*Oliarus hackeri*, dorsal view of head

Full view of pygofer figured; the lateral margins of pygofer entire, curved.

Head dark brown, carinæ and genæ light, white over fenestra, the median longitudinal carina of vertex dark. Pronotum light brown or yellow, dark brown

behind eyes and on lateral margins. Mesonotum reddish-brown, dark brown between the middle and medio-lateral carinæ and along the outer side of the lateral carinæ. Tegulæ yellow. Coxæ and femora dark brown, tibiæ and tarsi yellow. Abdominal sternites dark brown, with a fine light posterior margin; tergites light brown, a dark brown mark down the middle of anal segment. Tegmina clear hyaline, veins light brown, with minute granules bearing fine black hairs. Stigma yellow on outer portion, brown on inner; commissure dark brown to the apex of claval vein, then white or light to apex, which is dark brown. Wings hyaline with light brown veins, costal margin white.

There are five ♀ I place with this; one is similar in colour to the ♂, but the veins of tegmina are darker; the other four have an irregular and broken brown mark from near base of clavus, over *Cu* fork across to node.

Locality.—One ♂ from Brisbane (H. Hacker, 5th August, 1913, No. 24), five ♀ from Townsville (F. P. Dodd, September-November, 1902).

Type.—Type in British Museum (Natural History); paratype in Australian Museum, Sydney.

Iolania vittipennis sp. n.

(Fig. 5.)

♂. Length, 3 mm.; tegmen, 4·3 mm.

This genus is very close to *Cixius*, but there are no spines on the hind tibiæ except at the apex. Up till now it has been found only in the Hawaiian Islands.

Width of vertex at base subequal to length in middle, the base shallowly and roundly emarginate, the apex broadly angular, base broader than apex; the transverse carina near apex, angular; the medio-longitudinal carina distinct; frons slightly longer than broad, narrowest at base, broadest on apical half, median carina distinct, no median ocellus; clypeus tricarinate, the laterals continued from frons, flat, the base roundly produced into frons. Tegmina long, narrow, *Sc* + *R* forking two-thirds from base of corium, *Cu* about the same level, *M* beyond nodal line; the *M* stem lies near to *Cu* and in one specimen touches *Cu*.

FIGURE 5.
Iolania vittipennis, lateral view of male genitalia.

Head and pronotum light green or yellowish, slightly red in middle of frons and clypeus. Mesothorax dark brown. Tegulæ and legs light stramineous, abdomen dark. Tegmina hyaline, a dark brown mark from base of clavus to apical margin between *Cu* and *M*, this extends to the hind margin in clavus, veins the same colour as cells, apical margin brown, costal margin light. Wings hyaline with brown veins, fuscous over the posterior half and along the apical margin.

The genitalia figured. They show very little affinity to the Hawaiian species.

Locality.—Two ♀ and a damaged ♂ from Queensland (Dodd, 1904).

Type.—Type in the British Museum (Natural History); paratype in Australian Museum.

Iolania clypealis sp. n.

♂. Length, 2·3 mm.; tegmen, 3 mm.

Width of vertex slightly greater than length, apex slightly angular, base slightly emarginate; transverse carina slightly curved near apex, longitudinal median carina fine. Width of frons at apex greater than length in middle, widest at apex, median carina distinct, continued on to clypeus, no median ocellus; clypeus swollen, roundly produced into apex of frons (fronto-clypeal suture strongly curved), lateral carinæ fine, median carina distinct; on middle line clypeus longer than frons. Claval veins forked in middle of clavus, *Sc* + *R* fork and *Cu* fork about the same level, *M* fork beyond nodal line.

Frons, clypeus and genæ dark brown or black, the lateral carinæ of frons, the vertex, pronotum and tegulæ yellow; mesonotum dark brown, legs light brown, abdomen dark brown, genitalia lighter. Tegmina hyaline, slightly stramineous, veins light, apical veins light brown, veins with fine granules bearing dark hairs. Wings hyaline with darkish veins.

The absence of spines on the hind tibiæ brings this species into *Iolania* along with *vittipennis*, but they have little affinity with one another.

Locality.—Three ♂ from Brisbane, Queensland (H. Hacker, 18th November, 1911, No. 131).

Type.—Type in the British Museum (Natural History).

Tarberus jacobii sp. n.

(Figs. 6 and 7.)

♂. Length, 2·6 mm.; tegmen, 3·4 mm.

The claval veins forking a little before the middle of clavus, *Sc* + *R* and *Cu* forking about the same level, *M* forking at nodal line; *Sc* + *R*, *M* and *Cu* arising separately from basal cell; *M* with five apical veins, 1, 1*a*, 2, 3 and 4. Fairly slender form, tegmina tectiform. Length of vertex in middle less than width across base; apex much narrower than base, truncate; base deeply roundly emarginate; lateral carinæ straight, deep, the vertex excavate; in lateral view vertex straight, ascending, meeting frons at an angle less than 90°. Frons long, the base narrow, the apex wide, sides straight, no median carina, the laterals deep; the base of the clypeus extending roundly into the apex of frons. Clypeus long, slightly swollen, median carina distinct, extending from base to apex; laterals not so distinct, shorter. No median ocellus. Antennæ short, second segment about as long as broad. Pronotum very short in the middle, hind margin deeply and angularly emarginate; no median carina, the laterals following the hind margin of eyes, not reaching hind margin. Mesonotum tricarinate, the laterals diverging posteriorly, the disk between the laterals flat; the sides steep. No spines on hind tibiæ; hind basitarsus fairly long, second tarsus short, both with a row of small spines at apex.

This genus is very near to *Gelastocephalus* Kirk, but that genus has no lateral carinæ on clypeus and the lateral carinæ of frons curve round beneath the antennæ dividing the genæ from the lateral portions of the clypeus.

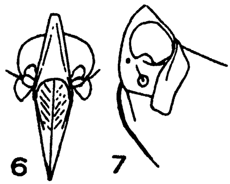

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FIGURE 6.—*Tarberus jacobii*, front view of head
FIGURE 7.—*Tarberus jacobii*, lateral view of head

Dark reddish-brown; the carinæ of head and thorax lighter. Tegmina light brown, slightly fuscous over nodal line and irregularly in apical cells, a darker mark at apex of each apical vein, the stigma and surrounding area white with brown specks; the outer claval cell opaquely white; veins with minute hair bearing granules, those in apical portion dark. Wings dark fuscous brown with dark veins.

Anal segment fairly large, rounded at apex; medio-ventral margin of pygofer produced into a small angular process; the genital styles spatulate, the apex broad and round.

This species differs somewhat from the type, *T. semicarinatus* Jacobi, so I have given the generic characters.

Locality.—One ♂ specimen, New Caledonia, Tontonta (P. A. Buxton, 4th June, 1925).

Type.—Type in British Museum (Natural History).

Nesocharis v-nigra sp. n.

♀. Length, 2·9 mm.; tegmen, 3·4 mm.

Apex of vertex narrow, a V-shape carina dividing vertex from frons. The medio-frontal carina continued on to the clypeus without a break, no median ocellus, the laterals also continued on to the clypeus. *Sc* + *R* forking about middle of clavus, *Cu* a little more distad, *M* at nodal line. *M* with five apical veins, 1, 1*a*, 2, 3, 4. Claval vein forking about a third from apex. Pygofer longer than broad; the ovipositor complete, extending beyond pygofer.

Light brown; the carinæ of head with a fine dark line; the lateral areas of mesonotum darker. Abdomen and genitalia dark brown, the posterior margins of sternites lighter. Tegmina brown, a large, irregular V black mark extending from apex of costa to apex of clavus and then to apical margin at *R*; the rest of the apical cells lighter brown with the apical margin white; the area within the V white. Two dark marks across costal cell and another in middle of clavus. Veins same colour as cells. Wings fuscous, light along the costal area, veins dark.

Locality.—One ♀ specimen, New Hebrides, Santo Island, Hog Harbour (P. A. Buxton, July, 1925).

Type.—Type in British Museum (Natural History).

DELPHACIDÆ.

Ugyops.

The distinctions between this genus and *Canyra* and *Livatis* are difficult to appreciate. The great variety in the shape of the head and condition of the carinæ appears to prevent such characters being used for generic purposes; the length and proportion of the two segments of the antennæ also are variable.

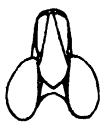
Ugyops longiceps sp. n.

(Figs. 8, 9, *a*.)

♂. Brachypterous; length, 5·8; tegmen, 3·8.

Length of vertex about twice the width, sides subparallel, apex slightly rounded and tumid, base angularly produced; two obscure carinæ, one on each side reaching from the middle of apex to the sides near base; the base about middle of eyes; more than half projecting in front of eyes. Frons long and narrow, length more than three times the width, widest on apical half; two median carinæ, subparallel, obscure at base and apex. No transverse carina on gena. Antennæ as long as frons and clypeus together, second segment 2·5 times the length of first. Carinæ on pro- and meso-nota obscure. Front tibiæ slightly longer than front femora. Tegmina and wings reaching to anal segment; claval veins forking near apex of clavus; *Sc* + *R* forking near base, *Cu* level with claval fork; *M* not forking; four obscure cross-veins, apical veins simple. Wings short but ample.

Genitalia figured.



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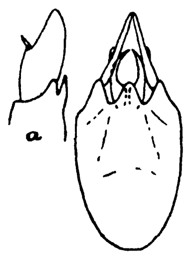

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FIGURE 8.—*Ugyops longiceps*, dorsal view of head.
FIGURE 9.—*Ugyops longiceps*, ventral view of male genitalia; *a*, lateral view of same.

Yellow or light brown; the tumid area at apex of vertex black and shiny, a fuscous mark on gena in front of eyes; red between the frontal carinæ. Basal segment of antennæ with a longitudinal dark mark, the second segment dark brown. Pygofer and anal segment dark on ventral half, light on dorsal. Tegmina light stramineous, veins dark with a few lighter spots. Wings light fuscous, veins dark.

♀. Length, 6·4 mm.; tegmen, 4·4 mm.

In build and colour similar to the ♂. Ovipositor reaching considerably beyond the anal segment.

Locality.—One ♂ and one ♀ from Queensland (Dodd, 1904).

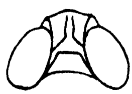
Type.—Type in British Museum (Natural History); paratype in Australian Museum, Sydney.

Ugyops musgravei sp. n.

(Figs. 10, 11, *a*.)

♂. Length, 6 mm.; tegmen, 4·4 mm.

Vertex about as broad as long, widest at apex which is slightly rounded, base straight; carinæ obscure especially at apex of vertex and base of frons. Length of frons less than twice the width, widest on apical half; two median carinæ obscure at apex and base. Antennæ not quite so long as frons and clypeus together, second segment nearly twice the length of first.



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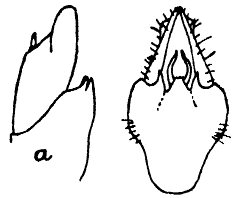

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FIGURE 10.—*Ugyops musgravei*, dorsal view of head.
FIGURE 11.—*Ugyops musgravei*, ventral view of male genitalia; *a*, lateral view of same.

Vertex and frons dark brown with a row of small light dots along the margins of the lateral carinæ and the outer margins of the median carinæ, apical portion of frons light; clypeus brown, lighter over carinæ. Antennæ brown, darker on apical portion of each segment. Pronotum and mesonotum light brown, darker on pronotum behind eyes. Legs light, front and middle tibiæ with darker bands. Hind coxæ and abdomen darker brown; the ventral half of anal segment and pygofer darker than the dorsal.

Tegmina reaching to middle of anal segment; *Sc* + *R* forking near base, *M* near apex and *Cu* a little distad of middle of clavus, claval veins forking level with *Cu* fork, about one-fourth from apex of clavus. Light stramineous, veins with a few dark marks; wings hyaline, very slightly fuscous, with dark veins.

The genitalia figured.

There is a female 6·4 mm. long which may be this species. It is lighter in colour with a black mark at base of corium and another just basad of nodal line. The ovipositor projects considerably beyond the anal segment. There are also two other females much smaller without the dark marks.

Locality.—Four ♂ and three ♀ from Lord Howe Island (Musgrave and Whitley, December, 1923).

Type.—Type in the Australian Museum, Sydney; paratype in the British Museum (Natural History).

Ugyops sulcata sp. n.

(Figs. 12, 13 and 14.)

♂. Length, 4·1 mm.; tegmen, 3·4 mm.

Vertex wider at apex than at base, length in middle considerably greater than width at apex (1·3 to 1), V-shape carina reaching about middle, apically carinæ forming a raised median area which continues down the frons with a sulcus down the middle. Length of frons twice the width, base slightly wider than apex,

widest on apical half; the longitudinal middle portion swollen with a sulcus down the middle. Antennæ nearly as long as frons and clypeus together, second segment longer than first (1·7 to 1), second segment slightly thickened. Tegmina extending slightly beyond anal segment; *Sc* + *R* forking a third from base of corium, *Cu* forking about a third from the nodal line, *M* at nodal line, first claval vein joining second about the middle of the latter.

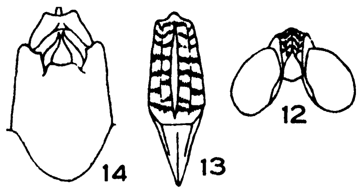

FIGURE 12.—*Ugyops sulcata*, dorsal view of head.
FIGURE 13.—*Ugyops sulcata*, front view of head.
FIGURE 14.—*Ugyops sulcata*, *ventral* view of male genitalia

The genitalia figured full view; the anal segment fairly short.

Stramineous or very light brown; the vertex from the V cross-vein to near the apex of frons a series of black and light patches, the sulcus in middle being plain. Apical portion of the second antennal segment fuscous; lateral portion of pronotum with some dark marks. Tegmina hyaline, slightly stramineous, a dark mark at apex of clavus, a smaller one at node, a few small fuscous marks on veins in corium and membrane. Granules very minute with fine black hairs.

♀. Similar in build and markings to ♂, the dark marks on veins in tegmina more definite, the front and middle femora with two dark bands. The ovipositor extending beyond the anal segment.

Localities.—New Hebrides; two ♂ and three ♀, Malekula Island, 15th July, 1925, Tanna Island, September, 1925, Santo Island, Big Bay, August, 1925 (P. A. Buxton); four ♀, Malekula Island, South-west Bay (J. J. Walker, 7th June, 1900).

Type.—Type in British Museum (Natural History); paratype in Australian Museum, Sydney.

Ugyops buxtoni sp. n.

(Figs. 15 and 16.)

♂. Length, 6 mm.; tegmen, 9·5 mm.

Vertex considerably longer than broad, apex and base subequal in width, base straight, apex produced in middle by the projecting median carinæ; the V carina reaching near to base, join together before apex and pass over to the frons together where they very shortly form a single fine median carina. Frons long, narrow, length 2·5 times the width, lateral margins slightly curved; the median carina at first formed of two contiguous carinæ and then amalgamated in one fine carina reaching to the apex. Antennæ slightly longer than frons, second segment very slightly longer than first. First claval vein joining second about the middle of latter; *Sc* + *R* and *Cu* forking about middle of corium, the latter slightly distad of former; the fork of *M* forming part of nodal line, M_{1+2} touching *R* and M_4 touching *Cu* for a short distance.

Full view of pygofer figured.

Light brown; carinæ of head finely lined with dark brown; pronotum dark behind eyes and the lateral portion of mesonotum dark brown; abdominal tergites dark, sternites light. Tegmina hyaline slightly yellowish, a dark brown mark at fork of M_3 and M_4 extending along M_3, another at apex of M_3 and M_4, another on apical margin between *R* and *M*, veins dark and light in fairly long portions, granules numerous and small bearing brown hairs. Wings hyaline, slightly fuscous, more so along apical margin, veins dark brown.

Localities.—Two ♂ from New Hebrides, Efate Island and Santo Island (P. A. Buxton, July, 1925).

Type.—Type in British Museum (Natural History); paratype in Australian Museum.

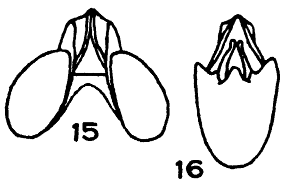
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FIGURE 15.—*Ugyops buxtoni*, dorsal view of head.
FIGURE 16.—*Ugyops buxtoni*, ventral view of male genitalia.

Phyllodinus kœbelei (Kirkaldy).

Fourteen specimens, all macropterous, from Efate Island, New Hebrides. This species is widely distributed in the South Pacific. It was first placed in *Phacalastor* Kirk., then in *Dicranotropis* and then in *Phyllodinus*. Ball has erected *Phyllodictus* for some of the species contained in *Phyllodinus*. The chief distinction between *Dicranotropis* and *Phyllodinus* is the flattened, expanded front and middle legs and as there appears to be a gradation in this respect it is hard to divide the two genera. The extra vein in the tegmina of some brachypterous forms is also variable. The name *kœbelei* is preoccupied in *Phyllodinus*, but until I am sure of the position of the present species I decline to give a new name.

Megamelus proserpina Kirkaldy.

Two specimens from New Hebrides, Santo Island, Big Bay, August, 1925 (P. A. Buxton).

Kelisia Kirkaldyi Muir.

One ♂ specimen from New Hebrides, Espiritu Santo Island, Hog Harbour, July, 1925 (P. A. Buxton).

DERBIDÆ.

Lamenia epiensis sp. n.

(Figs. 17, *a* and 18.)

♂. Length, 3 mm.; tegmen, 4·4 mm.

Head and pronotum yellow, the clypeus, apex of frons, the carinæ of frons and vertex and the middle of pronotum brown; mesonotum, tegulæ, abdomen and genitalia dark brown; the legs and posterior margins of abdominal sternites

light. Tegmina dark brown or nearly black, a large yellow mark at node with a brown spot in the middle. Wings fuscous brown with dark veins.

The genitalia figured. The shape of the apex of anal segment, the angular production of the lateral margin of pygofer and the shape of the genital styles distinguish it from *L. caliginea* Stål.

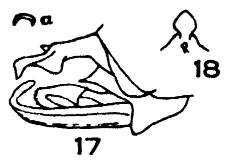


FIGURE 17.—*Lamenia epiensis*, lateral view of male genitalia; *a*, apex of anal segment.
FIGURE 18.—*Lamenia epiensis*, ventral view of apex of seventh abdominal sternite.

The ♀ similar to ♂ in build and colour. The posterior edge of pregenital segment (seventh abdominal sternite) figured.

Localities.—One ♂, three ♀ and one specimen without an abdomen. New Hebrides: Epi Island, 12th June, 1925; Pentecost Island, 21st June, 1925; Malekula Island, 15th June, 1925; Espiritu Santo, Hog Harbour, August, 1925 (P. A. Buxton).

Type.—Type in British Museum (Natural History), paratype in Australian Museum.

TROPIDUCHIDÆ.

Rhinodictya granulata sp. n.

♂. Length, 5·7 mm.; tegmen, 5·5 mm.

Vertex slightly longer than pronotum and mesonotum together, broadest at anterior corner of eyes, then narrowing slightly to base, median carina strong. Costal area narrower than in type.

Pale stramineous which in life may be green. The tegmina with distinct granules between the veins on clavus, corium and membrane. The carinæ of the head, laterals and medians distinct from apex to base.

The genital styles are joined together and there is a curved process on the left side.*

Locality.—Fiji Islands (H. W. Simmonds, 12th June, 1921, No. 477). One ♂.

This genus is allied to *Vanua* with similar genitalia.

Type.—Type in British Museum (Natural History).

Peggioga nigrifinis (Walker).

One ♂ and one ♀ from Solomon Islands, Guadalcanar Island, Lavoro Plantation (C. E. Hart, 1925, No. K 53971, K 53972). This genus also has the genital styles joined together.

Rhinodictya buxtoni sp. n.

♀. Length, 9·2 mm.; tegmen, 7·5 mm.

Length of vertex nearly twice the length of pronotum and mesonotum together (1 to 1·8); the head anteriorly laterally flattened slightly, the lateral carinæ of vertex and frons joining together half way between the eye and apex

of head, which in profile is truncate. Distinct granules all over the tegmina between the veins. Costal area narrower than in type of genus.

Pale green. Tegmina and wings hyaline, clear, veins light green.

Ovipositor similar to that in *Vanua*. Anal segment reaching slightly beyond the bases of the dorsal valvula, apex subangular. The apices of the dorsal valvulæ set with strong curved spines.

This differs from the type, *R. quæsitrix* Kirk., by the narrower costal area, the longer head, which is laterally flattened apically, and the granulation of the tegmina. From *R. granulata* it differs in its greater size, length of head, the flattening of the apex of head and the meeting together of the lateral carinæ of vertex and frons before the apex.

Locality.—New Hebrides, Malekula Island (P. A. Buxton, 5th July, 1925); one ♀.

Type.—Type in British Museum (Natural History).

Thaumantia insularis sp. n.

This species appears to differ from the genotype, *T. celebensis*, by the median pronotal carina being faint and not divided on the hind margin, and the apical and subapical cells being of equal length. The genus *Peltodictya* is closely allied, but has the forking of the *Sc* nearer the nodal line, otherwise the present species might be placed therein.

♀. Length, 7·7 mm.; tegmen, 10 mm.

Pale green. Tegmina and wings hyaline, clear, veins pale green.

Anal segment short, wide, apex with a small angular emargination in the middle, each half being rounded. In lateral view the dorsal valvulæ semi-crescent shape, at the apex thickened and turned outward, but without spines.

Locality.—Solomon Islands, Guadalcanar Island, Tenaru (R. W. Paine, 28th August, 1928), "in bush"; one ♀.

Type.—Type in British Museum (Natural History).

Kallitambinia g. n.

This genus combines the characters of *Kallitaxila* (Kirkaldy 1901 = *Taxilana* Melichar 1914) and *Tambinia*. The corium and clavus are thicker than the membrane and the cells are granulated. Length of vertex 1·3 the width, subconical in outline; median carina distinct. Frons much longer than wide, gradually increasing in width till antennæ, then decreasing, sides slightly sinuous. Clypeus wthout carinæ. Pro- and meso-nota as in *Tambinia*, the former deeply angularly emarginate and the latter about as long as wide.

Type.—*K. australis.*

Kallitambinia australis sp. n.

♀. Length, 5·2 mm.; tegmen, 6·1 mm.

Pale green. The clavus and corium darker green, the veins green. Wings hyaline with green veins.

Locality.—Queensland, Brisbane (H. Hacker, May, 1925, No. 198), five ♀.

Type.—Type in British Museum (Natural History); paratype in Australian Museum.

Pseudoparicana sanguinifrons sp. n.

♂. Length, 4 mm.; tegmen, 6 mm.

Head, pronotum and mesonotum yellow, the middle swollen portion of frons red, sides of clypeus black, the lateral margins of pronotum and the posterior half of mesonotum black or dark brown; the rest of thorax and abdomen black or dark brown, a yellow triangular mark on pleura of thorax, legs dark brown. Tegmina clear hyaline, veins brown, those in corium lighter; back of clavus black extending to costa and together with the posterior half of mesonotum forming a dark band; a dark band over nodal line extending from node round the apical margin nearly to apex of clavus. Wings hyaline with dark brown veins.

The genitalia are asymmetrical, the genital styles joined together to form a comparatively long process, the apical angles produced into flat angular processes curved upward and overlapping, thus forming a ring; the ædeagus is asymmetrical.

♀. In build and colour similar to ♂, but slightly darker in colour.

Locality.—New Guinea, Fly River (Geographical Society's Expedition, K 55378); one ♂ and two ♀.

This species is closely related to *P. curvifera* (Distant), the type of the genus. *P. tepida* Melichar is not typical. In the type the vertex (dorsal surface as seen from above) is sunken on the basal half, the frons swollen and shiny with a slight depression down each side; no carina down middle of vertex.

Lavora g. n.

Fairly narrow form; tegmina strongly tectiform. Vertex short and broad, length in middle about one-fourth of width, apical margin broadly rounded, base slightly more roundly emarginate, no median carina. The base of frons rounded and swollen and can be seen in dorsal view. Frons longer than broad (about 1 to 1·5); gradually increasing in width from base to beyond antennæ, then narrowing; base swollen and smooth, the swelling continuing on to the lateral margins; a large median carina continued on to the clypeus; on each side of the median carina, near the apex, are two very short, obscure carina continuing very faintly diagonally towards the eyes. Sides of clypeus rounded, without carinæ. Antennæ very short, second segment about as broad as long. Pronotum deeply angularly emarginate on hind margin, no median carina, lateral carinæ distinct; no distinct shoulder keels behind eyes; lateral margins of pronotum short, not extended posteriorly. Mesonotum about as long as broad, tricarinate. The tegmen figured; *Sc* + *R* forking near nodal line, *M* at nodal line, *Cu* distad of middle of corium; subapical line subgradate, from apex to clavus to the apical forks of *R*. The apical *M* and *C* veins forked. Claval veins forked about middle of clavus. Costal area distinct with about eight cross-veins.

This genus comes near *Vanua* Kirkaldy. It has similar genitalia, the genital styles amalgamated into a long narrow organ with a curved spine on the side. The four genera, *Vanua*, *Leptovanua*, *Peggioga* and *Rhinodictya*, all have this type and are undoubtedly allied. *Oligæthus* Jacobi I have not seen, but feel

sure it has a similar genital style. Their centre appears to be Australia and the South Pacific, extending westward to Amboina.

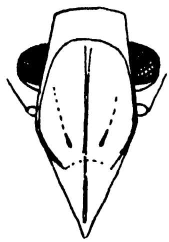
Type.—*L. ricanoides.*

Lavora ricanoides sp. n.

(Figs. 20, 21, 22, 23.)

♂. Length, 7 mm.; tegmen, 8 mm.

Stramineous, shiny; carinæ of head black, a bilobed black mark across the swollen portion of the base of frons, fuscous over the two small diagonal carinæ. The middle of the anterior margin, the middle of the posterior margin, the lateral margins and a mark behind the edge of pronotum black; the outer carinæ of mesonotum black. The middle and sides of abdominal tergites and the sternites fuscous. Tegmina clear hyaline, veins dark, the claval and *Cu* veins lighter; slightly fuscous over nodal line and at node; a small fuscous mark at apex of first *M* apical veins. Wings clear hyaline, veins dark brown, lighter in corium.



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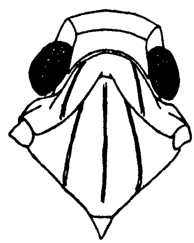

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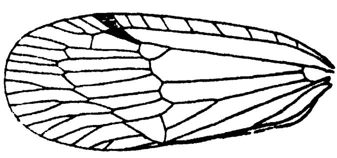
FIGURE 20.—*Lavora ricanoides*, front view of head.
FIGURE 21.—*Lavora ricanoides*, dorsal view of head and thorax



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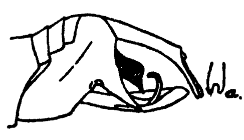

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FIGURE 22.—*Lavora ricanoides*, left tegmen.
FIGURE 23.—*Lavora ricanoides*, lateral view of male genitalia; *a*, apex of anal segment.

Left view of pygofer figured, the lateral right margin entire, not produced. Genital styles forming a single organ; anal segment cylindrical to anus, then slightly expanded with the apex emarginate.

Locality.—Solomon Archipelago, Guadalcanar Island, Lavoro Plantation (C. E. Hart, 1925); two ♂.

Type.—Type in Australian Museum, paratype in British Museum (Natural History).

MEENOPLIDÆ.

Nisia buxtoni sp. n.

(Fig. 19.)

♀. Length, 2 mm.; tegmen, 3·2 mm.

The two triangles at the base of vertex very minute. No medio-frontal or latero-clypeal carinæ. Antennæ fairly large. First claval vein strongly curved, granulated.

Stramineous; mesothorax darker. Tegmina hyaline, veins light, slightly fuscous on each side of the apical veins on apical margin and at the apex of clavus. Wings hyaline with light veins. Tegmina and wings opaque, with white, waxy secretion and the body also covered with the same. The wax secretions from the wax pad long.

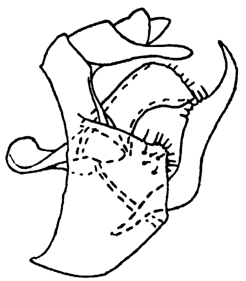


FIGURE 19.

Nisia buxtoni, lateral view of male genitalia.

The ♂ is similar to ♀ in build and colour. The genitalia are figured and show it distinct from any other species I am acquainted with.

Localities.—Three ♀ and one damaged ♂ from New Hebrides, Espiritu Santo, Hog Harbour (P. A. Buxton, July, 1925).

Type.—Type in the British Museum (Natural History), paratype in the Australian Museum, Sydney.

There is a second species which appears to be undescribed, but as it is represented by a ♀ only I do not feel disposed to describe it.

LOPHOPIDÆ.

Painella g. n.

Head slightly narrower than thorax. Vertex narrower at base than at apex, longer than broad at apex (1·3 to 1), margins not laminate, laterally very slightly raised; an obscure transverse angular carina about one-third from apex; a median longitudinal carina obscure on apical portion; base of vertex slightly roundly emarginate. The base and apex of frons subequal in width, gradually widening for two-thirds of its length and then narrowing, the lateral margin thus strongly angular, the width at the widest part greater than the length; a distinct median carina not reaching the base or apex; an obscure curved carina on each side. The

apex of vertex and the base of frons slightly tumid. A transverse ridge across gena starting from lateral angulation of the frons. The median carina on clypeus strong, the laterals not so distinct. Basal segment of antennæ very short, wider than long, second segment about twice as long as broad. Pronotum considerably shorter than vertex; tricarinate, the laterals slightly diverging posteriorly, not quite reaching the hind margin, the median not quite reaching the fore or hind margins; posterior margin straight. Mesonotum longer than pronotum or vertex, nearly as long as both together, tricarinate, the carinæ being in line with the pronotal carinæ. Front tibia expanded, thin, width slightly more than half the length; front femur as long as tibia, expanded less than tibia, width less than half the length (1 to 2·4). Second tibia and femur flat and thin, but not so wide as front, the length about four times the width. Hind tibia with three strong spines, one in the middle, one near apex and one between, the apical spines not confined to apical margin, apex forming a pad. Hind basitarsus fairly long, slightly thickened, more so apically, the small spines not confined to the apical margin, but extending somewhat basally, forming a small triangular pad; second segment very small without any spines.

The genitalia are of the usual Lophopid type; in the male the ædeagus consists of an inner penis and an outer periandrium; in the female the dorsal valvulæ are produced into round, thin plates with wax glands on both sides, and the apex of the anal segment is expanded and bears wax glands.

Tegmina macropterous, costal margin nearly straight, apical margin nearly straight, oblique; the costal area narrow with a few cross-veins in apical area. The costa reaching to the apex, no stigma; *Sc* and *R* forking near base, *M* forking about level with apex of clavus, *Cu* forking about level with claval fork, claval fork about one-fourth from apex of clavus; no nodal line and only a few irregular and obscure cross-veins in membrane not making an apical line; about 15 to 16 long, narrow apical cells.

Type.—P. harti.

In 1927 the writer described *Buxtoniella* from Samoa, and remarked that its position and origin was an enigma. The present genus stands between it and *Virgilia* Stål. *Buxtoniella* was described from brachypterous specimens, and if no macropterous form exists then the peculiar tegmina will distinguish it from all other Lophopidæ; its short mesonotum is no doubt connected with its wing reduction. From *Virgilia* the genus *Painella* is separated by its broader frons, the reduction of the medio-lateral carinæ on frons, the simple, single median carina on mesonotum, the great expanse of the front tibia and femora, the margins of vertex not being elevated and the absence of anything like an apical line in the tegmina.

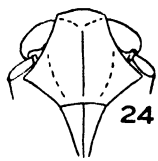
Painella harti sp. n.

(Figs. 24 and 25.)

♂. Length, 4 mm.; tegmen, 5·4 mm.

Vertex greenish, a black mark across the base and another at the transverse carina; frons black, shiny, a broken, narrow green mark across the base, another very narrow one slightly basad of the widest portion and another, a little wider, slightly more apical, the base of clypeus greenish, apical portion fuscous; genæ greenish, black round ocelli. In the second specimen the green on frons is wider

and the two apical bands are joined in the middle. Pronotum dark brown on anterior half, greenish on posterior half; mesonotum dark brown; tegulæ brown with a light mark. Pleura greenish with light brown marks. Front legs brown with a few lighter marks; middle legs lighter; hind legs with femora dark brown with a longitudinal greenish line, tibiæ and all tarsi light brown. Abdomen dark brown. Tegmina dark brown or black with hyaline marks, one forming a large triangle, the base occupying the middle third of costa and the apex nearly reaching the apex of clavus, a dark spot in the middle of the base; a quadrate light spot on the costa nearer the apex, a small one on apical margin at the middle and a small, angular one at the posterior angle; a couple of small light marks on costa at base. Wings dark fuscous, light over basal portion. In the type specimen the black spot in the hyaline triangle spreads out and cuts the light spot into two small spots.



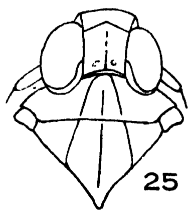


FIGURE 24.—*Painella harti*, front view of head.
FIGURE 25.—*Painella harti*, dorsal view of head and thorax.

The eighth abdominal segment reduced to a very slender tergal sclerite with a spiracle situate at either end. Pygofer very short dorsally, wide ventrally. Genital styles straight on inner margins where they meet together, outer margins nearly straight, with a small spine near the middle, apex subtruncate. Anal segment in dorsal view subcordate in outline, the lateral margins being angularly produced and curved downward, the apex with a slight angular emargination.

♀. Length, 6·7 mm.; tegmen, 6·9 mm.

In general build and colour similar to the ♂, but the middle legs are decidedly narrower.

Locality.—Solomon Islands, Guadalcanar Island. Two ♂ specimens from Tenaru (R. W. Paine, 27th August, 1928), "in bush" and one ♀ from Lavoro Plantation (C. E. Hart, 1925).

At present there is no good character separating the Lophopidæ from the Eurybrachidæ, the width of the face being of no importance in this connection. Both groups want a re-examination and better morphological characters used for their classification.

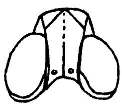
Type.—Type in British Museum (Natural History); paratype in Australian Museum, Sydney.

Painella simmondsi sp. n.

(Figs. 26, 27 and 28.)

♂. Length, 4·6 mm.; tegmen, 5·3 mm.

This differs from the type species in having the front and middle femora and tibiæ much narrower and parallel sided and the transverse V carina reaching the apex, but it is so closely related that it would be illogical to erect another genus for it, although the expanded legs have generally been considered as of generic value. The tegmina is slightly longer and narrower, the costal area slightly wider, the apical margin slightly more rounded and the membrane longer, the apical cross-veins are also more regular and make a distinct but faint apical line. It approaches *Virgilia* more than *P. harti* does.



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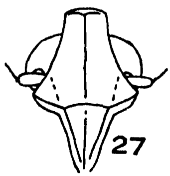

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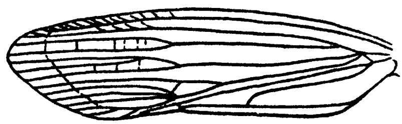

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FIGURE 26.—*Painella simmondsi*, dorsal view of head.
FIGURE 27.—*Painella simmondsi*, front view of head.
FIGURE 28.—*Painella simmondsi*, left tegmen.

Vertex light brown with a darker mark across the base and another across the apical half. Frons light brown or yellow, in one specimen bright green, with two curved blood-red bands, one at the base and one across the middle, a small black mark at apex and another in the middle of clypeus. Pronotum light brown, dark in the middle. Mesonotum dark brown, carinæ slightly lighter, two lighter spots in the middle, the posterior angle lighter. Tegulæ lighter. Legs light, two longitudinal fine black lines on front femora; hind femora mostly dark.

Costal area and cell and the major portion of subcostal and radial cells light, rest of corium dark brown, clavus dark brown, the marginal cell light; membrane mostly dark brown, the dark portion occupying the middle, extending to the apex of costal margin and inner angle, a dark mark across the tip and several small marks across the costal area. Wings fuscous with a light area along costa.

♀. Length, 5·8 mm.; tegmen, 7·0 mm.

In build similar to ♂, the tegmina lighter with the apex rounder. The dorsal valvulæ forming large, rounded plates, the apex of anal segment also expanded, both bearing wax glands.

Locality.—Solomon Islands, New Georgia, one ♂; Gaudalcanar, two ♂ (R. W. Paine, July, 1928), one ♀ (H. W. Simmonds).

Type.—Type in British Museum (Natural History).

RICANIIDÆ.

Plestia.

This genus is at present only known from some of the south Pacific islands and Australia. Three species are known from New Hebrides, two from Samoa, one from New Caledonia and three from Fiji, one of which is also reported from Australia. This shows a high endemism and further work in other islands is sure to reveal further species. When describing *P. anomala* from Samoa I mentioned the fact that it had a row of marginal cross-veins, a character which in other groups of the same family is considered of generic value. This is so closely related to *P. kellersi* from the same locality that it is impossible to place them in separate genera. In fact I have hesitated to place them as different species. Anyone living in Samoa could very easily breed these and ascertain their relationship and the stability of the apical cross-veins.

There is considerable variation in the stigma and apical subcostal cells in the different species, the value of which can only be ascertained by long series, but the point is of interest and worth ascertaining by resident entomologists.

Plestia viridis sp. n.

(Fig. 29.)

♀. Length, 3·9 mm.; tegmen, 6·2 mm.

In build typical; the *Sc* and *R* amalgamated to node, without the least sign of a subcostal cell. Light green, the abdomen and middle of mesonotum stramineous. Tegmina clear hyaline without marks, stigma light yellow, the costal and *Sc* + *R* veins light, other veins dark brown. Wings clear hyaline with dark brown veins.

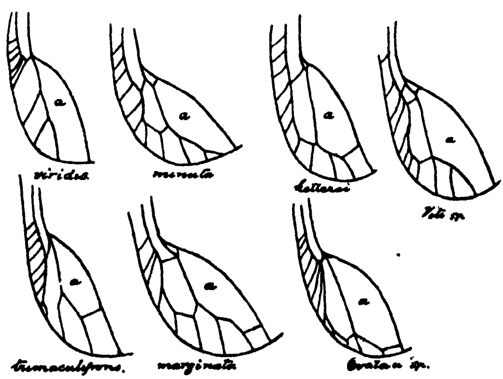

FIGURE 29.—*Plestia* species, apices of tegmina.

Locality.—New Hebrides, Efate Island, Vila (P. A. Buxton, July, 1925), two ♀.

Type.—Type in British Museum (Natural History); paratype in Australian Museum, Sydney.

Plestia minuta sp. n.

(Figs. 29, 30, *a*.)

♂. Length, 3 mm.; tegmen, 4·6 mm.

The *Sc* and *R* quite distinct with a very narrow cell between them. Basal two-thirds of frons light brown, the apical third white, a tendency for the base to be light; clypeus dark brown; anterior part of pronotum brownish, also the lateral areas, posterior part light with a slight greenish tinge; mesonotum darker brown with an irregular, mottled lighter mark across; tegulæ light. Front legs light, second and hind femora darker. Abdominal tergites yellow, brown in the middle, sternites brown. Anal segment and sides of pygofer light, styles dark brown. Tegmina and wings hyaline with brown veins; costal area and cell and the *Sc* cell dark brown extending slightly at the base of *Rs* and the *Sc* apical cells, a white spot at apices of veins entering costal and apical margin, those on costal extending across costal area, a series of white spots (about 10) in basal two-thirds of costal cell; some dark brown marks in basal cell and in clavus; fuscous over inner hind margin of wings.

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FIGURE 30.
Plestia minuta, front view of genital styles; *a*, lateral view of same.

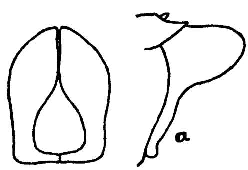

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FIGURE 31.
Plestia marginata, front view of genital styles; *a*, lateral view of same.

The inner margins of genital styles sinuous, only meeting together at the apex.

Locality.—New Hebrides, Efate Island, Vila, August, 1925, and Santo Island, Hog Harbour, August, 1925 (P. A. Buxton); four ♂.

This species comes very near to *P. marginata*, but it is much smaller, the marks in costal area are more linear, those in costal cell more distinct, the clypeus dark and the genitalia different (Fig. 31, *a*.)

Type.—Type in British Museum (Natural History); paratype in Australian Museum, Sydney.

Plestia trimaculifrons sp. n.

(Fig. 29.)

♂. Length, 4·6 mm.; tegmen 7 mm.

The *Sc* and *R* distinct, but contiguous to near apex, so there is only a small *Sc* cell at the apex. The frons longer than in the genotype and the base narrower, width about 1·5 times the length. Light brown or stramineous; frons white over the greater portion of middle with three black marks at base, the middle one quadrate, the laterals subtriangular, a little darker marking on vertex, pronotum and mesonotum, the hind margin of pronotum dark; the eyes banded light and

dark. Hind femora darker brown. Abdomen greenish with the hind margins of tergites brown. Tegmina clear hyaline; costal cell light yellow, stigmal area brown, the *C*, *Sc* and *R* light, other veins dark, cross-veins in costal area distinct, dark brown; brown at apex of *Sc* cell. Wings clear hyaline, veins brown, fuscous along hind margin.

♀. Similar to ♂, but slightly larger in size.

Locality.—New Hebrides, Efate Island, Vila, July, 1925; Epi Island, 12th June, 1925); Malekula Island, Bushman's Bay, 28th August, 1925 (P. A. Buxton). Four ♂ and two ♀.

Type.—Type in British Museum (Natural History); paratype in Australian Museum, Sydney.

There is one specimen from Ovalau, Fiji, and several from "Viti" which apparently represent two other species, but as the specimens are old and in bad condition, I refrain from describing them. Figures of the stigma and apical subcostal cells are given for comparison.

Aprivesa varipennis sp. n.

♂. Length, 6·5 mm.; tegmen 9·0 mm.

There is no transverse carina across the base of frons as in *A. exuta* (Melichar), the medio-laterals are short and obscure and join the base of the frons, otherwise it is quite typical. The stalk of *Sc* + *R* is very short, the fork of *R* is more distad and *Cu* still more distad, about level with claval fork; the apical and subapical cell about equal in length. Frons dark brown on base, yellow on apex, slightly mottled between; clypeus brown, lighter down middle. Vertex and pronotum dark brown, the lateral portions of pronotum with lighter marks; mesonotum dark brown, nearly black. Thoracic pleura dark; legs light brown. Abdominal sterna yellow, the fourth, fifth and sixth bearing circular depressions which are darker in colour; the terga dark brown. Tegmina fuscous brown mottled with hyaline, most numerous over costal area and membrane; veins brown. Wings hyaline with brown veins, lighter in corium.

The frons is darker in one specimen and the legs brown.

♀. Similar to ♂.

Locality.—One ♂ and three ♀ from Western Australia, Carnarvon (E. L. Grant-Watson).

Type.—Type in British Museum (Natural History); paratype in Australian Museum, Sydney.

HERPETOLOGICAL NOTES.

No. 2.*

By

J. R. KINGHORN, C.M.Z.S.,

Zoologist, The Australian Museum.

(Figures 1–3.)

Brachyaspis curta Schlegel.

(Figure 1.)

After an examination of nine young and eight adult specimens of this species, I am able to make the following observations. In the adults the frontal shield is a little wider than the supraocular, but in the young this difference is hardly noticeable; it varies slightly in length and shape generally, but the remaining characters do not differ to any extent from those noted by Boulenger in his description. In the very young specimens the head appears to be much flatter and more swollen than in the adult, but this is due to the bulging of the eyes, a condition that may be caused by the preservative. In one specimen the frontal is rounded posteriorly and in another sharply pointed, and this would cause a slight difference in its length in comparison with its distance from the snout, the variation throughout the series being from a little longer to one and one-half times as long as its distance from the snout. In another, the frontal is very distorted and is broken up into four distinct shields. As a general rule the frontal is one and one-half times as long as broad, about half as wide again as the supraoculars, longer than its distance from the end of the snout, about as long as the parietals but longer than the suture between them. The internasals are only about half the size of the prefrontals.

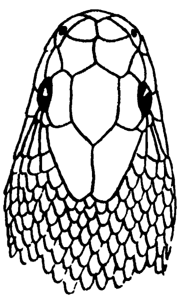

FIGURE 1.

The eye is larger than its distance from the mouth. The rostral is about one-third broader than deep, the part visible from above being shorter than the suture between the internasals.

In the eight specimens examined the nasal forms a suture with the single preocular. There are two postoculars and six upper labials, though Boulenger noted that there may be six or seven upper labials. There are seven lower labials, three of which are in contact with the anterior chin shields. Scales in 19 rows round the centre of the body; ventrals 131–138; subcaudals 31–41, all single; temporals 2 + 2 or 2 + 3, in one example 2 + 3 on the left side and 3 + 3 on the right.

* For No. I see RECORDS OF THE AUSTRALIAN MUSEUM, Vol. xvii, No. 2, 1929, pp. 76-89.

The colour is reddish brown above and yellowish beneath, and there may be some mottlings or indistinct stripes over the angle of the jaw and on the side of the neck and snout. The specimens, apart from the very young, vary in length from 160 mm. to 550 mm.

The distribution of the species, according to Mr. L. Glauert, is the north-west district of Western Australia, besides the following localities: Muchea, Perth district, Denmark, Albany, Laverton, Warredar Station, all in that State.

The stomachs of three specimens contained the remains of frogs, while that of the largest contained a lizard (*Lygosoma*). One snake only seven inches in length had a *Lygosoma* three and three-quarter inches in length in its stomach.

The oviducts of one contained eight eggs.

In the specimen with the abnormal frontal there are several other abnormalities worthy of mention. There is a small azygous scale under the left eye between the third and fourth upper labials, and two small azygous scales between the third and fourth labial under the right eye. As the fourth labial is somewhat smaller than it should be, I would consider that the azygous shield is part of that labial.

The illustration is drawn from specimen, registered number R.2403, National Museum, Melbourne.

Chersydrus granulatus Schneider.

This species may now be added to the herpetological fauna of the Solomon Islands, three specimens having been collected at north Malaita by Mr. G. S. White in November, 1928. Previously it was not known further east than Papua and on the north-east coast of Queensland as far south as Cairns.

Demansia guttata Parker.

(Figure 2.)

Through the courtesy of the Director, Mr. J. A. Kershaw, of the National Museum, Melbourne, I recently examined specimens of this species and made a drawing, which I publish here, the species not having been figured previously. The specimen differs from the typical in having 19 scales round the body; it was collected at Avon Down, Queensland, by Mr. H. J. Lloyd in March, 1927.

National Museum collection, registered number R.11846.

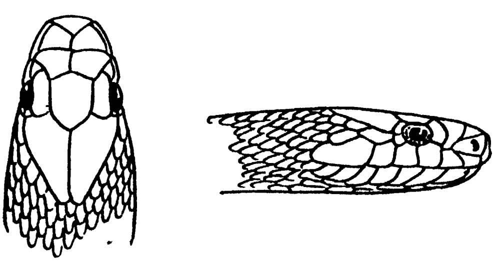

FIGURE 2.

Denisonia maculata var. devisii, Waite and Longman.

This is an inland species usually regarded as being distributed throughout the northern half of New South Wales and up to about central Queensland. A

specimen in the National Museum, from Longreach, Queensland, has 19 scales round the centre of the body instead of the usual 17; otherwise it is typical.

Rhinhoplocephalus bicolor Mueller.

(Figure 3.)

Recently I had the opportunity of examining two specimens of this species. One, in the National Museum, Melbourne, is illustrated here, the species being figured for the first time, while the other is in the Western Australian Museum, and from it I offer the following description:

Snout broad, truncate. Eye equal in size to its distance from the mouth. Rostral from above, one and one-half times as broad as long. Frontal a little longer than broad, as long as its distance from the end of the snout, shorter than the parietals but longer than the suture between them; twice as broad as the supra-ocular scales. Prefrontal slightly smaller than the rostral; no internasals; nasal in contact with the preocular; two postoculars; temporals 2 + 2. Six upper labials, the third and fourth under the eye. Seven lower labials. Anterior chin shields longer than the posterior and separated by a large scale. Three lower labials in contact with the anterior chin shields. Total length 322 mm. Tail 47 mm.; 15 scales round the centre of the body; 149 ventrals; 1 anal; 29 subcaudals.

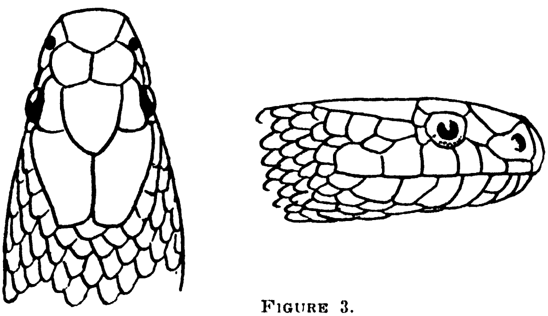

FIGURE 3.

Locality: Wagin, Western Australia. The stomach contained the remains of a frog.

The specimen in the National Museum measures 345 mm. It has 15 scales; 31 subcaudals; 156 ventrals; temporals 1 + 2. It is from Western Australia, and is figured above.

Delma fraseri Gray.

A beautiful specimen in full breeding colour was recently added to the collection from East Cannington, Perth, Western Australia. It is olive brown above and whitish below, the head being somewhat darker than the back. There is a conspicuous brick-red streak on each side of the body from behind the ear to the tail, but this is broken up along the posterior portion, the centre of each scale being red, the tip black, and the base white.

Between the ear and the eye the red is missing, the scales being black and white. The colours have faded in spirits and now after several months have become very dull, though still distinct.

An abnormal specimen in the National Museum is worthy of note, though it is without data. The frontal shield is smaller than the prefrontal instead of larger, and the third upper labial is situated under the eye.

Egernia whitei carnarae sub-sp. nov.

Differs from the typical in that the fronto-nasal is not in contact with the frontal, the prefrontals forming a suture which separates the two shields. The frontal is much longer than the fronto-parietal. There are four temporals and three pairs of nuchals. The adpressed limbs meet but do not overlap. There are 34 scales round the centre of the body. The colour is rich brown above, the typical longitudinal lines being broken up into series of white dark-edged longitudinal spots. The sides are marked with white dark-edged ocelli.

Total length 230 mm.; body 85 mm.; axilla to groin 48 mm.

As I have only one specimen I refrain from giving this new lizard full specific rank.

Locality: Between Canara district and North West Cape, Western Australia. Collected in August, 1929, by Mr. David G. Stead.

Australian Museum collection, registered number R.9981.

Tiliqua occipitalis auriculare sub-sp. nov.

This *Tiliqua* differs from the typical *T. occipitalis* in several characters, but, as only one specimen is available, these are not considered to be of sufficient importance to warrant its being described as a distinct species. The most outstanding character is the enormous ear opening, after which I have named the sub-species.

Distinguishing characters: ear opening about twice as long as the eye opening, with five inconspicuous blunt lobules. There are forty-five scales round the centre of the body. The interparietal shield at its broadest is nearly as broad as the parietal. The feet and toes are small and weak in comparison with those of *T. occipitalis*. The general colour above is pale brown with twelve reddish brown cross bands on the body and eleven on the tail.

The measurements, in comparison with three typical specimens of *T. occipitalis*, are given below in millimetres.

	T. o. auriculare.	*T occipitalis.*		
Head and body	230	240	260	240
Length of head	56	60	61	55
Width of head	47	44	45	40
Width of body	60	52	45	51
Fore limb	47	51	51	51
Hind limb	51	51	53	51
Axilla to groin	141	152	150	136
Ear opening	13	8	8	6
Eye opening	7	7	7	5

The specimen was collected at Broome, north-western Australia, in 1929 by Mr. A. A. Livingstone of this Museum. Registered number R.10080.

Hatching of Lizards.

Very little is known regarding the hatching of lizards' eggs in their natural surroundings, but the following notes will show that the transportation of the same does not always interfere with incubation.

Lygosoma ͵Lioleplsma metallicum O'Shannessy.

Several eggs were submitted to me during February, 1929, but I was not able to determine the species, so I left them for some days in a tobacco tin on my

table. On opening the tin again I found that the eggs had hatched and, except for two dead lizards, the rest of the young were extremely lively.

Lepidodactylus woodfordi Boulenger.

Occasionally exotic species have been recorded from the Australian mainland, particularly near some sea port, and these are usually transported in bunches of bananas, copra, or other produce, by island steamers. An interesting case came before me some time towards the end of the year 1928. A Sydney resident found a gecko egg in an orchid which he had imported from Fiji; this hatched out while he was bringing it to the Museum, and proved to be the above rare species.

Interesting Additions to the Collections.

The Rev. H. E. Warren and staff of the Mission Station at Groote Eylandt, Gulf of Carpentaria, collected and forwarded to the Museum the following species, which can be regarded as new records and added to the fauna of that area.

Chersydrus granulatus, 1; *Pseudelaps harriettæ*, 2; *Natrix mairii*, 1; *Acanthophis antarcticus*, 1; *Typhlops minimus*, 2[1]; *Tiliqua scincoides*, 1; *Varanus punctatus*, 1; *Chlamydosaurus kingii*, 1; *Amphibolurus muricatus*, 7; *Diporophora bilineata*, 12; *Ablepharus boutonii*, 4; *Lygosoma Hinulia lesueurii*, 5; *L. Lygosoma mundum*, 9; *Hyla phyllochroa*, 3; *Limnodynastes ornatus*, 1; *Hyla peronii*, 3; *Hyla nigrofrenata*, 5; *Hyla nasuta*, 5.

At Hinchinbrook Island, Mr. A S. Le Souef collected the following: *Rana papua*, *Lygosoma Liolepisma albertisii*, and *Lygosoma Homolepida punctulatum*. *L. albertisii* is a new record, not only from the island, but, as far as I am aware, from Queensland. The late Dr. W. E. J. Paradice secured a specimen at Observation Island, Gulf of Carpentaria in 1925, and recently Mr. M. Ward found it on Lindeman Island, Whitsunday passage, and Messrs. G. P. Whitley and W. Boardman collected one at Lake Barrine, north Queensland. Previously the species was recorded only from Papua and the islands of Torres Strait.

Mr. Ward was successful also in securing a large collection of reptiles at Cape York, and it contained the following rare lizards: *Lygosoma Emoa atrocostatum*; *L. Hinulia elegantulum*; *L. Hinulia lesueurii* var. *inornatum*; and *L. Liolepisma fuscum*; the latter, which is found mainly in the Moluccas and Papua, is regarded as exceptionally rare in Queensland.

The Mating Ceremonial of the Bearded Dragon.

Amphibolurus barbatus Cuvier.

The following valuable, and perhaps unique, note was sent to me by Dr. C. S. Sullivan, from Moree, New South Wales, and I am recording it in his own words, with very few alterations:

"One afternoon in August, 1929, I was wandering in the scrub near Moree, when I came upon a pair of Bearded Dragons whose appearance and attitude were so unusual that I retired quickly and watched developments by the aid of field glasses from a spot some six or eight yards away. What I took to be the female was coloured a dull slaty-black with a few faint mottlings of greyish-white. The only bright touch about her was a patch of dull red on the side of the body near

[1] Described and figured by me as a new species in RECORDS OF THE AUSTRALIAN MUSEUM, Vol. xvii, No. 4, 1929, p 190

the base of the tail and opposite the inner side of the thigh. This sexual colour patch was only seen later on, however, when she moved.

"The male appeared to be totally black underneath the body and head, including the beard and the whole of the lower jaw, not the dull black of the female, but a rich glossy purplish-black. The upper surface was in marked contrast, varying from a light mottle grey and yellow on the back to a bright light green on the head, especially on the snout near the nostril. He had a conspicuous patch of light green on the spot which was red in the female. The basal half of the tail was grey and light yellow, but the last four or five inches were dull black, the junction between the yellow and black being clearly marked.

"The female when first seen was lying motionless and quite flattened out, and the male was lying across her, the midline of his body crossing her back about the region of the vent. There was no movement for about three minutes except that the male appeared to yawn once, opening wide his yellow mouth. Suddenly he became active. First he stamped loudly two or three times with one or both of his forelegs, making a much louder sound than one would have thought possible. Then he ran quickly round in front of the female, taking up a position almost at right angles to, and some two feet in front of her. He now stamped once with the left foot and proceeded to jerk his head up and down in a most ludicrous manner, each jerk being followed by a pause of perhaps a second (it looked as if the skull had been dislocated from the atlas, allowing a ventro-dorsal movement of the whole head upon the rigid vertebral column). The beard was stretched to its fullest extent, and the trunk raised high on the forelegs while the mouth was opened at intervals. Suddenly he moved forward with a swift little run until his head was held exactly over that of the female who was still crouched flat on the ground. This position was maintained for a few seconds when the male threw himself in a lightning-like leap, and when my eyes had recovered from the shock of trying to register so quick a movement, I saw that he now lay at full length on the female's back and was gripping with his jaws either the spines on the back of her head or the skin covering the nape.

"His forelegs were quite off the ground, and his hind ones barely touching. His body was no longer slim like that of the female but was widened out giving the round 'carapace' appearance so familiar to anyone who ever angered these reptiles by submitting them to the undignified ordeal of being held up by the tail. The female, now for the first time, gave indication that she was actually alive, till now she literally had not blinked an eyelid. She ran along keeping flat to the ground while the male's legs beat the air frantically as he hung on with his jaws, and his colour became even brighter than before. The female went about six feet before she stopped but the male continued to paw the air and lash his tail from side to side. After a minute or two he scrambled off and ran out of sight of the female behind a low bush. Here, with his trunk raised high off the ground on his forelegs, he began to jerk his head again, but after about thirty seconds quietened down, and in three or four minutes had almost regained his normal colour. Finally he ran about two feet up a small sapling while the female lay where he had left her without a movement of any sort.

"I was sitting down vigorously scribbling and trying to record what I had witnessed when I heard a rushing sound and looked up to see the male dragon charging towards me. He had changed colour again, and was really a most fear-

some sight as he pranced along, his purplish-black beard greatly expanded and glistening in the sun, his mouth wide open disclosing the bright yellow mucous membrane, contrasting strongly with the bright green above and the brilliant black beneath. Having no desire to be mistaken for a sapling I rose with considerable alacrity, but the dragon had stopped. Then he stamped once and ran round in front of the female again.

"After some preliminary 'showing off' by means of the head jerking, he went through the whole performance again. After about a minute his jaws relaxed their hold on his partner's occiput, and immediately she scuttled out from underneath and took refuge in a low, dense scrub. The male ran off and again took up his position on the sapling, where, after a little head jerking, he quietened down and regained his normal colour. After five or ten minutes he brightened up again, turned round and hung on head downwards while he stamped and jerked his head in the same manner as when he was on the ground. He then descended, pranced round a little and soon climbed about eight feet up another sapling, jerking his head and occasionally looking about as if trying to catch the eye of his mate.

"I waited in vain for further developments for half an hour after the female had gone to earth, then I lost patience and pulled aside the branches that hid her. I noticed that she had lost the reddish 'sexual' patch, she was very sluggish, and could only be persuaded to emerge with the aid of a stick; I threw her a few feet away, whereupon she ran up another branch of the tree in which her suitor was, taking up her motionless stance some five feet above him. In three or four minutes the male began to don his wedding garment again, stamped loudly a few times with his left fore foot on the back of the sapling, and jerked his head spasmodically once more, but the fair charmer paid no heed to him whatsoever, and after a few minutes he resumed his duller, normal colour. I waited another half-hour but nothing more eventuated, so I finally left them to the pleasure of their own society."

ETHNOLOGICAL NOTES.

No. 3.*

By

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Ethnologist, The Australian Museum.

(Plates ix-x.)

Aboriginal Pebble-Axes.

The "improvised axe," "pebble-axe," or "pebble-chopper" is fairly plentiful on the coastal middens of certain parts of New South Wales and Victoria.[1] They are, however, not restricted to the seaboard, typical examples having been ploughed up some thirty miles from the sea. Probably they range still further inland, but because of their apparent unimportance have been passed over, or thought to be of accidental origin. These implements are sometimes disregarded by the ordinary collector, because of their obviously elementary technique. Kenyon[2] not only recognized them as a normal type, but considered them as being in the line of development of the normal ground axe.

The opportunity is now taken of figuring and describing a score or more, of varied technique, from different localities on the coast and the immediate hinterland. There are two forms of this elementary implement. The greater number are flaked at the ends, while others, though rarer, are similarly treated on the side; the latter[3] type conform more to the title of pebble-choppers, because of the technique employed. Both types are flaked from one side only, which process brings about a more or less sharp cutting edge. Their use is conjectural,[4] for, though the normal ground axe is found in association with them, one cannot assume that they were made and used for the same purposes. This is another example of the problem associated with aboriginal stone implements, where the flaked and ground varieties are found side by side.[5]

As implied in the name, these implements are made from water-worn pebbles. Whether these were brought to the coast from the rivers or derived from beach shingle is not known; it is possible that they were obtained from both sources. In addition to igneous material, fine-grained sandstone, quartzite and quartz-felsite were used. The petrological determinations[6] which are included in this article are based on lithological characters only; for precise identifications thin sections would be necessary.

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* Numbers I and II were published in RECORDS OF THE AUSTRALIAN MUSEUM, Vol. xvi, No. 5, 1928, p. 241, and Vol. xvii, No. 8, 1930, page 348.

[1] Found also in Tasmania, *fide* J. S. Falkinder.

[2] Kenyon, A. S.—*The Victorian Naturalist*, xliii, February, 1927, p. 284.

[3] These are common on the North Coast of New South Wales, *fide* C. C. Towle.

[4] Horne says they were used for "detaching the molluscs." *Victorian Naturalist*, xxxviii, 1921, pp. 48-53.

[5] *Cf.* Spencer, *The Arunta*, London, 1927, pp. 536-7.

[6] Stones identified by T. Hodge-Smith.

Because of their abundance in many localities, it is thought that these axes or choppers, being readily made, were as readily discarded. Be this as it may, these implements do not show signs of considerable use, hence the belief that they were improvised. On the other hand, some examples (Plate ix, fig. 2) seem to have been retouched on the working edges, when it has been necessary to re-sharpen them. The probability of the removed flakes being used has not been overlooked, though this is extremely unlikely. In examining coastal middens one invariably finds that the more suitable and compact siliceous material is made use of for flake-work.

One cannot imagine that these pebble-axes were hafted, as was the practice with many of the ground-edge variety. The belief that the pebble-axe is a stage in the development of the ground axe is tenable.[7] One of the figured specimens shows attrition after flaking (Plate ix, fig. 2). There does not appear to be any uniformity of size, shape or weight in these implements. Apparently any suitable pebble was chosen, some being but ounces in weight, while others weigh a pound or more. The butt ends and flat sides often show secondary utilization, being pitted or bruised by pounding.

All the specimens described were collected by the writer and presented to the Museum, and show the development and variation from the simple to the more complex forms.

The bibliography, arranged chronologically, which follows may prove useful to those who are desirous of studying aboriginal middens, shelters, and workshops, and the stone implements frequently found at these sites.

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[7] *Cf.* Kenyon, A. S., *Victorian Naturalist*, xliii, February, 1927, p. 284.

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EXPLANATIONS OF PLATES.

PLATE IX.

Fig. 1.—Sandstone; removed flakes with one exception, probably due to accident; small. Weight, 8 ozs.; dimensions, 11½ × 7 × 2½ cms. Locality, Bellambi, New South Wales. Australian Museum registered number, E.33231.

Fig. 2.—Sandstone; bean-shaped; flaked at pointed end; evidence of secondary attrition. Used also as an anvil. Weight, 12 ozs.; dimensions, 11¼ × 6½ × 2¾ cms. Locality, Bellambi, New South Wales. Australian Museum registered number, E.33232.

Fig. 3.—Basalt; flat and ovoid in outline; flaked on end; pitted with pounding. Weight, 8 ozs.; dimensions, 11⅝ × 7⅝ × 1⅞ cms. Locality, Murramurang, New South Wales. Australian Museum registered number, E.33233.

Fig. 4.—Sandstone; long oval in shape; well but irregularly flaked. Weight, 14 ozs.; dimensions, 14¼ × 7¼ × 2⅝ cms. Locality, Bellambi, New South Wales. Australian Museum registered number, E.33234.

Fig. 5.—Basalt; the heaviest of the series; flaked; cutting edge retouched; ploughed up in alluvium. Weight, 3 lbs. 4 ozs.; dimensions, 18½ × 10½ × 5¾ cms. Locality, Emu Plains, New South Wales. Australian Museum registered number, E.33235.

Fig. 6.—Quartzite; flat; highly flaked over two-thirds of periphery. Weight, 1 lb.; dimensions, 14½ × 8⅝ × 3½ cms. Locality, Bellambi, New South Wales. Australian Museum registered number, E.33236.

Fig. 7.—Quartzite; irregular in outline; heavily flaked, leaving a rather thick butt. Weight, 1 lb.; dimensions, 13¼ × 8¼ × 4 cms. Locality, Murramurang, New South Wales. Australian Museum registered number, E.33237.

Fig. 8.—Basalt; ovoid; thick; removed flakes rather small. Weight, 1 lb. 6 ozs.; dimensions, 13 × 9 × 4½ cms. Locality, Emu Plains, New South Wales. Australian Museum registered number, E.33238.

Fig. 9.—Quartzite? Original form nearly circular; heavily flaked and more pointed than usual. Weight, 14 ozs.; dimensions, 10½ × 8⅝ × 3¾ cms. Locality, Murramurang, New South Wales. Australian Museum registered number, E.33239.

Fig. 10.—Quartzite; heavily flaked and probably retouched, producing a facetted cutting-edge. Weight, 1 lb. 2 ozs.; dimensions, 11⅝ × 10 × 4¼ cms. Locality, Lake Illawarra, New South Wales. Australian Museum registered number, E.33240.

Fig. 11.—Basalt? Ovoid; figured side almost entirely flaked. Weight, 1 lb. 8 ozs.; dimensions, 11¼ × 4⅝ cms. Locality, Bellambi, New South Wales. Australian Museum registered number, E.33241.

Fig. 12.—Basalt; figured side flaked all over, producing a celt-like appearance. Weight, 1 lb. 6 ozs.; dimensions, 15⅝ × 7⅞ × 4¼ cms. Locality, Emu Plains, New South Wales. Australian Museum registered number, E.33242.

Fig. 13.—Basalt; figured side almost entirely flaked; one margin serrated. Weight, 1 lb. 2 ozs.; dimensions, 14½ × 7½ × 3⅝ cms. Locality, Emu Plains, New South Wales. Australian Museum registered number, E.33243.

Fig. 14.—Sandstone; figured side flaked all over. Weight, 10 ozs.; dimensions, 12¾ × 8½ × 2¼ cms. Locality, Murramurang, New South Wales. Australian Museum registered number, E.33244.

PLATE X.

Fig. 15.—Basalt? Considerably pitted with age; cutting edge blunted by weathering; visible scars produced by plough. Weight, 2 lbs. 2 ozs.; dimensions, 17¼ × 10 × 4½ cms. Locality, Emu Plains, New South Wales. Australian Museum registered number, E.33245.

Fig. 16.—Basalt? Also pitted and corroded with age; flaking indistinct. Weight, 1 lb. 9 oz.; dimensions, 13⅝ × 10 × 4 cms. Locality, Murramurang, New South Wales. Australian Museum registered number, E.33246.

Fig. 17.—Quartzite? Practically a retouched split pebble; margin notched. Weight, 6 ozs.; dimensions, 9⅝ × 8⅞ × 2¼ cms. Locality, Murramurang, New South Wales. Australian Museum registered number, E.33247.

Fig. 18.—Igneous rock, pebble considerably reduced; working end notched. Weight, 4 ozs.; dimensions, 8¼ × 6⅛ × 2½ cms. Locality, Murramurang, New South Wales. Australian Museum registered number, E.33248.

Fig. 19.—Sandstone? Considerably reduced and irregular. Weight, 5 ozs.; dimensions, 9⅝ × 6⅝ × 3 cms. Locality, Lake Illawarra, New South Wales. Australian Museum registered number, E.33249.

Fig. 20—Basalt? Portion of pebble only, with notched margin. Weight, 7 ozs.; dimensions, 8⅝ × 3¼ cms. Locality, Murramurang, New South Wales. Australian Museum registered number, E.33250.

Fig. 21.—Basalt; bean-shaped; side-flaked; inclined to thickness. Weight, 1 lb. 5 ozs.; dimensions, 15 × 7½ × 4½ cms. Locality, Emu Plains, New South Wales. Australian Museum registered number, E.33251.

Fig. 22.—Quartzite, skilfully side-flaked. Weight, 12 ozs.; dimensions, 11⅝ × 7½ × 3½ cms. Locality, Murramurang, New South Wales. Australian Museum registered number, E.33252.

Fig. 23.—Igneous rock; pitted with age; used also as a pounder; flakes removed on reverse side, but probably intentional. Weight, 12 ozs.; dimensions, 13¼ × 6⅝ × 2⅝ cms. Locality, Murramurang, New South Wales. Australian Museum registered number, E.33253.

Fig. 24.—Quartzite; a pebble considerably reduced. Weight, 8 ozs.; dimensions, 9⅝ × 6⅝ × 3½ cms. Locality, Kembla Beach, New South Wales. Australian Museum registered number, E 33254.

Fig. 25.—Quartz-felsite, pebble still more reduced, figured side entirely flaked. Weight, 10 ozs.; dimensions, 11⅝ × 6½ × 3⅝ cms. Locality, Murramurang, New South Wales. Australian Museum registered number, E.33255.

Fig. 26.—Quartz-felsite; pebble crudely flaked. Weight, 9 ozs.; dimensions, 11⅝ × 7⅝ × 3¼ cms. Locality, Murramurang, New South Wales. Australian Museum registered number, E.33256.

Fig. 27.—Quartz-felsite; a split pebble with chipped cutting edge. Weight, 8 ozs.; dimensions, 11⅝ × 9 × 2¼ cms. Locality, Murramurang, New South Wales. Australian Museum registered number, E.33257.

STUDIES IN ICHTHYOLOGY.

No. 4.*

By

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Ichthyologist, Australian Museum, Sydney.

(Plates xi-xvi and Figures 1-2.)

Family RHINOBATIDÆ.

Genus **Aptychotrema** Norman, 1926.

Aptychotrema rostrata (Shaw and Nodder).

(Plate xvi, fig. 2.)

Raja rostrata Shaw and Nodder, Nat. Miscell. v, Apr. 1, 1794, pl. clxxiii. No locality. Type locality, Botany Bay, New South Wales, by present designation.

Rhinobatus (*Rhinobatus*) *banksii* Müller and Henle, Syst. Plagiost. iii, 1841, p. 123. Ex *Raja rostrata* Banks MS. New Holland. Based on a drawing in the British Museum.

Rhinobatus (*Syrrhina*) *banksii* Müller and Henle, Syst. Plagiost. iii, 1841, p. 192. New Holland. Specimen in Royal coll., Vienna. *Id.* Duméril, Hist. Nat. Poiss. (Suite à Buffon) i, 2, 1865, p. 490. A Banksian specimen in the Paris Museum.

Rhinobatus tuberculatus Macleay, Proc. Linn. Soc. N. S. Wales, vii, 1882, p. 12. Port Jackson. *Nomen nudum.*

Rhinobatus banksii Waite, Austr. Mus. Mem., iv, 1899, p. 38, pl. iii. *Id.* Ogilby, Mem. Qld. Mus., v, 1916, p. 85, fig. 1, left.

Aptychotrema banksii Norman, Proc. Zool. Soc. Lond., 1926, p. 978, fig. 30. *Id.* Whitley, Fish. N. S. Wales (McCulloch), ed. 2, 1927, first page of additions (key characters reversed in error).

Aptychotrema rostrata Mussgrave and Whitley, Austr. Mus. Magazine, iv, 1931, p. 150 and photo. (Trial Bay, N. S. Wales).

Whilst at Trial Bay, northern New South Wales, in December, 1929, I secured several embryos of this species from parents nearly three feet long. Four were removed from one female and are preserved in the Australian Museum. These are 122 to 124 mm. long and have each a subspherical yolk-sac about 30 mm. in diameter.

Raja rostrata is apparently the earliest name for this species. Though figured by Shaw and Nodder from no stated locality, it bears the same name as that used by Banks in his manuscripts, and the figure is probably copied from the Banksian drawing in the British Museum upon which Müller and Henle based their name. It agrees well with Waite's figure, published over a century later, and has the eyes closer together than in the allied Australian species, *Aptychotrema bougainvillii* (Müller and Henle).

McCulloch[1] has figured the egg and embryos of *Aptychotrema vincentianus* (Haacke), which I regard as a distinct southern species, distinguishable by its

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* For No. 3 see RECORDS OF THE AUSTRALIAN MUSEUM, Vol. xvii, No. 3, 1929, p. 101.

[1] McCulloch.—Biol. Res. "Endeavour," v, 4, 1926, p. 157, figs. 1-4.

less attenuate snout. The accompanying photographs of the Trial Bay specimens of *A. rostrata*, for which I am indebted to Mr. Anthony Musgrave, will serve for comparison. The eggs are evidently hatched within the body of the parent, but I do not know what length is attained by the embryos before birth.

Family RAJIDÆ.

Irolita, gen. nov.

Orthotype, *Raja waitii* McCulloch.

Raja waitii McCulloch[2] obviously deserves a generic appellation of its own as it is doubtfully congeneric with the South American *Psammobatis* Günther, with which it has been associated by authors. Furthermore, *Psammobatis* Günther[3] may be regarded as preoccupied by *Psammobates* Fitzinger,[4] a genus of reptiles, to which my attention was attracted when looking through some proof-sheets of Sherborn's "Index Animalium." *Malacorhina* Garman[5] may apparently be employed for the South American genus as Regan[6] has suggested its identity with *Psammobatis*, and the new genus *Irolita* will apply to the South Australian *Irolita waitii* (McCulloch).

Glauert[7] has extended the range of this species to south-western Australia.

Family DASYATIDÆ.

Genus Tæniura Müller and Henle, 1837.

Tæniura Müller and Henle, Ber. Verh. K. pr. Akad. Wiss. Berlin, 1836 (1837), p. 117; Arch. Naturg. (Wiegmann), iii, 1, 1837, p. 400; Mag. Nat. Hist. (Charlesw.) n.s., ii, 1838, p. 90. Haplotype, *Trygon ornata* Gray.

Trygon Geoffroy St. Hilaire, Egypte (Savigny), i, 1, Poiss. Mer Rouge, 1827, p. 333. Not *Trygon* Cuvier, 1816 (*fide* Sherborn, Index Anim., and Jordan, Gen. Fish.).

Discobatis Miklouho-Maclay and Macleay, Proc. Linn. Soc. N. S. Wales, x, 4, April 3, 1886, p. 678. Haplotype, *D. marginipinnis* M. and M. Preoccupied by *Discobatis* Garman, Proc. U.S. Nat. Mus., 1881, p. 523, another genus of Rays.

Discotrygon Fowler, Proc. Acad. Nat. Sci. Philad., lxii, 2, Aug. 17, 1910, p. 468. New name for *Discobatis* M. and M., preocc. Orthotype, *D. marginipinnis* M. and M.

Tæniura lymnia halgani (Lesson).

(Plate xi.)

Raja lymma Forskaal, Descr. Anim. 1775, p. 17. Loheia, Red Sea. This work is non-binomial.

Raia lymnia Bonnaterre, Tabl. Encycl. Meth. Ichth., 1788, p. 5. Based on *Raja lymma* Forskaal. Red Sea.

? *Raia lymma* Hamilton-Buchanan, Acc. Fish. Ganges, 1822, p. 361 (*fide* Fowler, Proc. Acad. Nat. Sci. Philad. lvii, 1905, p. 460, footnote 8).

Trygon lymna Cloquet, Dict. Sci. Nat., xxxviii, 1825, p. 62.

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[2] McCulloch.—Zool. Res. "Endeavour," i, Dec. 22, 1911, p 12, pl. iii and text-fig. 4.
[3] Günther.—Cat. Fish. Brit. Mus., viii, 1870, p. 470.
[4] Fitzinger.—Ann. Wiener Mus., i, 1, 1835, p. 113.
[5] Garman.—Proc. Boston Soc. Nat. Hist., xix, 1878, pp. 203 and 207.
[6] Regan.—Brit. Antarct. Exp., Zool., i, 1, 1914, p. 22.
[7] Glauert.—Journn. Roy. Soc W. Austr., vii, 1921, p. 45.

Trygon lymma Geoffroy St. Hilaire, Egypte (Savigny), i, 1, Poiss. Mer Rouge, 1827, p. 333, pl. xxvii, fig. 1. Red Sea (Ref. from Sherborn, Ind. Anim.).

Trigon lymma Rüppell, Atlas zu Rüppell, Reise (Senckenb. Nat. Ges.), Fische, 1829, p. 51, pl. xiii, fig. 1; Neue Wirbelth. Abyssin., Fische, 1837, p. 69, pl. xix, fig. 4. Red Sea.

Trygon lymnæ Swainson, Nat. Hist. Classif. Fish. Amphib. Rept. ii, July, 1839, p. 319. Based on Rüppell, 1829. [Red Sea.]

Tæniura lymma Müller and Henle, Syst. Plagiost., pt. 3, 1841, p. 171. *Id.* Richardson, Rept. 12th meet. Brit. Assn. Adv. Sci., 1842 (1843), p. 30 (Australia).

Trygon ornatus Gray, Illustr. Indian Zool., i, 2, "1829" = March, 1830, pl. xcix. Singapore.

Trygon halgani Lesson, Voy. Coquille, Zool. ii, Dec., 1830, p. 100, pl. iii. Waigiou and New Ireland.

Discobatis marginipinnis Miklouho-Maclay and Macleay, Proc. Linn. Soc. N. S. Wales, x, 4, April 3, 1886, p. 676, pl. xlvi, figs. 7-15. Based on drawings of a specimen with a mutilated tail from Sorry or Wild Island, Admiralty Group.

Tæniura lymma Klunzinger, Verh. Zool.-Bot. Ges. Wien., xx, 1870, p. 681. *Id.* Günther, Cat. Fish. Brit. Mus., viii, 1870, p. 483, and Journ. Mus. Godef., vi, 17 (Fische Südsee, ix), 1910, p. 495. *Id.* Macleay, Proc. Linn. Soc. N. S. Wales, vii, 1883, p. 598 (New Guinea). *Id.* Ogilby, Proc. Linn. Soc. N. S. Wales, x, 1885, pp. 463 and 465 (Cape York, Q., and New Guinea). *Id.* Fowler, Proc. Acad. Nat. Sci. Philad., lxii, 1910, p. 473 (Sumatra). *Id.* Ogilby, Mem. Qld. Mus. i, 1912, p. 31 (Darnley I., Q.). *Id.* Weber, Siboga Exped., Fische, May, 1913, p. 604. *Id.* Garman, Mem. Mus. Comp. Zool. Harvard, xxxvi, Sept., 1913, p. 399, pl. lii, fig. 4; pl. lv, fig. 7, and pl. lxxi, figs. 4-5 (anatomical). *Id.* Ogilby, Mem. Qld. Mus., v, 1916, pp. 87 and 95. *Id.* McCulloch, Rec. Austr. Mus., xiii, 1920, p. 41, pl. x (Murray I. specimen figured). *Id.* Whitley, Austr. Zool., iv, 1926, p. 228. *Id.* Paradice and Whitley, Mem. Qld. Mus. ix, 1927, p. 78 (Pellew Group). *Id.* Barnard, Ann. S. Afr. Mus., xxi, 2, 1927, p. 1015. *Id.* Fowler, Mem. Bishop Mus., x, 1928, p. 25.

Tæniura lymna McCulloch and Whitley, Mem. Qld. Mus., viii, 1925, p. 130 (Queensland).

When illustrations of Red Sea, Singapore, Australian, and Pacific specimens of *Tæniura lymnia* are compared, slight differences of shape, coloration and size of eyes are noticeable. Perhaps comparison of a series of specimens from diverse localities would show variations of subspecific or even specific value because actual specimens generally differ more than their illustrations; but I am unable to make autoptical comparisons in this case and accordingly use *T. lymnia* as the earliest binomial name for this stingray. The teeth of a topotypical example figured in Rüppell's "Neue Wirbelthiere" are notably sharper than in my specimens so that, should further differences be discovered, the Australian form may be called *Tæniura halgani* (Lesson). An excellent illustration of a specimen nine inches in width, from Murray Island, Queensland, was given by McCulloch, whilst a new-born example collected by Mr. M. Ward in the Whitsunday Passage, Queensland, is figured here.

Other specimens in the Australian Museum came from North-west Islet, Brampton Island, St. Crispin Reef, and Cape York, Queensland; Port Darwin

and the Sir Edward Pellew Group, North Australia. I found the species very common at Low Isles, North Queensland. A specimen from Batt Reef, near by, had remains of prawns, mantis shrimps, and polychæte worms in great numbers in the stomach.

Dampier[8] figured a specimen of *Tæniura lymnia halgani* from New Guinea and remarked: "This Fish is a pale red with blew spots on y^e body the long tail blew in y^e middle and white on y^e side."

Some nominal species of *Tæniura* may be considered here. Gray[9] recorded *Tæniura meyeni* Müller and Henle[10] from Cape Upstart, Queensland, but I have not seen a specimen of this species from Australia.

Macleay[11] described *Tæniura atra* from New Guinea. The type, from Port Moresby, is preserved in the Australian Museum (No. I.9762). It measures 35 inches in length, including the tail, and is 16 inches wide. It belongs to the genus *Pastinachus* Rüppell.[12] Pending comparison with Red Sea specimens of *P. sephen* (Bonnaterre),[13] it may be regarded as a subspecies: *Pastinachus sephen ater* (Macleay).

Macleay[14] also described *Tæniura mortoni* as a new species from the Burdekin River, Queensland, but the type is lost; no specimen bearing that name is now preserved in either the Macleay Museum, University of Sydney, or the Australian Museum. There is, however, a specimen of *Pastinachus* from Macleay's Burdekin River collection in the Australian Museum and, as it agrees with Macleay's brief description of *T. mortoni*, I regard that species as synonymous with *Pastinachus sephen ater* (Macleay).

Family CHIROCENTRIDÆ.

Genus **Neosudis** Castelnau, 1873.

Neosudis vorax was the name given to a supposed new genus and species of fishes from New Caledonia by Castelnau[15] with the remark, "I can only place this remarkable fish with the *Scopelidæ*, and its dorsal fin, placed on the posterior part of the body, would bring it near *Sudis*." The systematic position of *Neosudis* has been a puzzle to subsequent workers. O'Shaugnessy[16] placed it in the Scopelidæ, Jordan and Seale[17] in the Paralepidæ, Regan[18] regarded it as a doubtful Scopelarchid, Jordan[19] put it in the Evermanellidæ, and Parr[20] considered it as

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[8] Dampier.—Cont. Voy. New Holland, 1709.

[9] Gray.—List. Spec. Fish. Brit. Mus., i, Chondropt., 1851, p. 124.

[10] Müller and Henle.—Syst. Plagiost, pt. 3, 1841, p. 172. Mauritius.

[11] Macleay.—Proc. Linn. Soc. N. S. Wales, vii, 4, April, 1883, p. 598.

[12] Rüppell.—Atlas zu Rüppell, Reise (Senckenb. Nat. Ges.), Fische, 1829, p. 51, footnote. Logotype, *Dasybatus sephen* [= *Raia sephen* Bonnaterre], designated by Garman, Mem. Mus. Comp. Zool. Harv., xxxvi, Sept., 1913, p. 375.

[13] Bonnaterre.—Tabl. Encycl. Meth., Ichth., 1788, p. 4, as *Raia*. *Ex* Forskaal, non-binomial. Red Sea.

[14] Macleay.—Proc. Linn. Soc. N. S. Wales, viii, 2, July 17, 1883, p. 212.

[15] Castelnau.—Proc. Zool. Acclim. Soc. Vict., ii, May 10, 1873, p. 119.

[16] O'Shaugnessy.—Zool. Record, 1873 (1875), p. 120.

[17] Jordan and Seale —Bull. U.S. Bur. Fish., xxv, 1906, p. 190.

[18] Regan.—Ann. Mag. Nat. Hist., (8), vii, 1911, pp. 127 and 130.

[19] Jordan.—Classif. Fishes, 1923, p. 154.

[20] Parr.—Bull. Bingham Oceanogr. Coll., iii, 3, 1928, p. 32, footnote.

possibly deserving of family rank. Fowler[21] gave a précis of the characters of *Neosudis* and followed Jordan and Seale in placing it in the Paralepidæ.

As the work in which Castelnau's description appeared is apparently rather rare in libraries, though still obtainable in Melbourne, I reproduce herewith the original account.

"NEOSUDIS.

"Body very elongate; height eight and a-half times in the total length; head six times and one-third in the same; eye four and two-thirds in the head; body compressed, very elongate, sharp below; head also compressed; the lower jaw considerably longer than the upper one; chin salient and rounded; teeth strong, slender, almost straight, apart one from the other; those of the upper jaw much shorter than those of the mandible, with the exception of the two front ones, which are often unequal in length and directed obliquely forwards; the lower teeth are very long, pointed, directed backwards. The opening of the mouth is superior, and the maxillaries extend further than the edge of the eye; eyes covered by a veil; the operculum rounded; upper surface of the head depressed between the eyes, with three longitudinal ridges, the central one abbreviated; body covered with minute scales; dorsal unique inserted very considerably behind the middle of the body, and at about two-thirds of its length; this fin is about two-thirds of the length of the head; it has sixteen rays, the posterior ones and the base of the others are covered with scales, and the fin has an adipose appearance; the caudal is very deeply forked, formed of twenty long rays and of a considerable number of shorter ones on each side; anal inserted a little behind the beginning of the dorsal, and over twice as long as this; it is covered in great part by scales, and the rays are difficult to count, numbering twenty-six to twenty-eight; the anterior rays are considerably longer than the others. Ventrals very small, of about one-fifth the length of the pectorals, placed a little nearer to the base of the pectorals than to that of the anal, and formed of eight stiff rays; the lower ones formed of a sort of broad lamina, which is also the case with the dorsal and anal; pectorals situated near the lower edge of the operculum, of fourteen rays; they are nearly as long as two-thirds of the head.

"I can only place this remarkable fish with the *Scopelidæ*, and its dorsal fin, placed on the posterior part of the body, would bring it near *Sudis*.

"NEOSUDIS VORAX.

"Silvery, with the upper parts of a dark slate colour; dorsal, ventrals, and anal, white; caudal rather yellow, bordered with black.

"The largest of my specimens is over twenty-four inches in length.

"Noumea, New Caledonia."

From this it is evident that Castelnau's fish is not even a member of the order Iniomi, to say nothing of the families of that order to which it has been referred. *Neosudis* lacks an adipose second dorsal or fat fin, although Castelnau described the true dorsal as having an adipose appearance. It has small eyes, compressed belly, low pectorals, and insignificant eight-rayed ventrals, but the unusually backward insertion of the single dorsal fin is the main diagnostic character which separates *Neosudis* at a glance from the Iniomi.

I regard *Neosudis* Castelnau as a synonym of the Clupeoid genus *Chirocentrus* Cuvier,[22] with which it agrees in detail. *Neosudis vorax* is perhaps a synonym of *Clupea dorab* Bonnaterre,[23] the genotype of *Chirocentrus*, from the Red Sea. Nevertheless it seems inadvisable to sink it as a synonym on present evidence as comparison of Red Sea and Pacific specimens would probably show specific or subspecific differences. The New Caledonian form may therefore be known as

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[21] Fowler.—Mem. Bishop Mus., x, 1928, p. 66.

[22] Cuvier.—Règne Animal, ed. 1, ii, "1817" = Dec., 1816, p. 178.

[23] Bonnaterre.—Tabl. Encycl. Meth., Ichth., 1788, p. 187, *ex* Forskaal, non-binomial.

Chirocentrus dorab vorax (Castelnau) and be removed from the order Iniomi and placed in the family Chirocentridæ of the order Isospondyli, suborder Clupeoidei. A brief note to this effect appeared in the Abstract of the Proceedings of the Linnean Society of New South Wales, No. 429, September 27, 1929, subsequently reprinted in the Proceedings, Vol. liv, 6, 1930, p. l.

The tautotype of the genus *Chirocentrus* is "l'esoce chirocentrus" or *Esox chirocentrus* Lacépède,[24] based on a drawing by Commerson of a fish without definite locality. This and *Clupea dentex* Bloch and Schneider,[25] from the Red Sea, are regarded as synonyms of *Chirocentrus dorab* (Bonnaterre). *Chirocentrus nudus* Swainson[26] is based on a figure of an Indian example, with the scales rubbed off, given by Russell.[27] Richardson[28] introduced the name *Esox clupeoides*, from the MSS. of Broussonet for a Madras specimen. *Chirocentrus hypselosoma* Bleeker[29] from Singapore and Samarang has been shown to be distinct from *C. dorab* by Hardenburg[30] and this name and *C. nudus* have precedence over *vorax* Castelnau if conspecific. It is noteworthy that Cockerell[31] in describing the scales of "*Chirocentrus dorab*" from Queensland, suggested that this species may not be identical with *C. dorab* from the Philippines. Ogilby[32] has given further notes on the Queensland form, which is probably identical with the New Caledonian *C. dorab vorax*.

Family MURÆNIDÆ.

Genus **Gymnothorax** Bloch, 1795.

Gymnothorax Bloch, Nat. ausl. Fische, ix, 1795, p. 83; Ichtyologie, vi, pt. 12, 1797, p. 67. Logotype, *G. reticularis* Bloch.

Taxonomy.—I am unable to consult the original "Nat. ausl. Fische" in which *Gymnothorax* was first proposed, but quote from the "Ichtyologie" edition wherein the genus is defined as follows: "Mr. Thunberg l'a séparée des anguilles et en a fait, et avec raison, un genre séparé [a] [Footnote [a]] (Specimen ichthyologiæ de Muræne. Upsal. 1789). Mais, comme Mr. Thumberg [*sic*] a donné à ces poissons le nom de Murénes, nom que Linné donne aussi aux anguilles, je leur ai donné celui de Gymnothorax, afin d'éviter toute confusion; et cette denomination fait connoître en même temps la marque distinctive du genre." It is thus obvious that *Gymnothorax* is a substitute name for *Muræna* Thunberg (*nec* Linné, Syst. Nat., ed. 10, 1758, p. 244). Bloch, however, added two species to those already described by Thunberg; *viz.*, *G. catenatus* (pl. 415, fig. 1) from Surinam, and *G. reticularis* (pl. 416) from Tranquebar. It is thus reasonable to suppose that one of the species of *Muræna* Thunberg (non Linné[33]) should be the genotype of *Gymnothorax* and not *G. reticularis* as selected by Bleeker.[34]

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[24] Lacépède.—Hist. Nat. Poiss., v, 1803, p. 296, pl. viii, fig. 1.
[25] Bloch and Schneider.—Syst. Ichth., 1801, p. 428.
[26] Swainson.—Nat. Hist. Classif. Fish. Amphib. Rept. ii, July, 1839, p. 295.
[27] Russell.—Fish. Vizag., ii, 1803, p. 78, pl. cxcix, as *Clupea dorab?*
[28] Richardson.—Rept. 15th meet. Brit. Assn. Adv. Sci., 1845 (1846), p. 311.
[29] Bleeker.—Nat. Tijdschr. Ned. Ind., iii, 1852, p. 71.
[30] Hardenburg.—Treubia, xii, 1, 1930, p. 51.
[31] Cockerell.—Mem. Qld. Mus., iii, 1915, p. 37.
[32] Ogilby.—Mem. Qld. Mus., v, 1916, p. 96.
[33] Linné.—Syst. Nat., ed. 10, 1758, p. 244. Type, *Muræna helena* Linné.
[34] Bleeker.—Atlas Ichth., iv, 1865, p. 73.

Thunberg's work on the eels is not available to me, but I find from Sherborn's invaluable "Index Animalium" and Jordan and Gilbert's notes[35] that he described the following species:

Muræna nebulosa	Thunberg,	De Muræna,	1789,	p. 7.
Muræna annulata	"	"	"	p. 8.
Muræna picta	"	"	"	p. 9.
Muræna fasciata[36]	"	"	"	p. 9.

Bloch mentioned these four species in a footnote and, therefore, perhaps the correct course to pursue would be to name one of them as genotype of *Gymnothorax*, but I prefer not to add to the confusion which has been caused in spite of Bloch's desire to avoid it and I therefore regard *G. reticularis* as the logotype of *Gymnothorax* as selected by Bleeker; this is one of the species mentioned under the original definition of the genus and is therefore available as genotype.

Jordan[37] was in error in stating that *Gymnothorax* "was plainly a substitute name for *Muræna* and must retain the same type, *Muræna helena* L." He quoted Günther's restriction of *Gymnothorax* to the allies of *Muræna afra* but Günther made no formal genotype designation, as Bleeker did. It may be noted that Jordan later[38] accepted Bleeker's interpretation of this genus.

Thus *Gymnothorax* Bloch is not a synonym of *Muræna* Linné and the genotype, selected by Bleeker, is *G. reticularis* Bloch. By accepting this finding, it will not be necessary to alter the customary usage which the International Commission on Zoological Nomenclature has sought to stabilize by opinion.[39]

Family SYNGNATHIDÆ.

Genus **Phyllopteryx** Swainson, 1839.

Phyllopteryx lucasi sp. nov.

(Plate xv, fig. 1.)

Hippocampus foliaceus Richardson, Rept. 12th meet. Brit. Assn. Adv. Sci., 1842 (1843), p. 28. "New Holland" = Western Australia, by present designation. *Nomen nudum.*

Phillopteryx elongatus Castelnau, Proc. Zool. Acclim. Soc. Vict., ii, May, 1873, p. 144. Fremantle, W. Austr. Not *P. elongatus* Castelnau, *ibid.* i, 1872, p. 243, from South Australia.

Phyllopteryx foliatus Duncker, Faun. S.W. Austr., ii, Pisces i, 1909, p. 236. W. Australian ref. only. Not *Syngnathus foliatus* Shaw, Gen. Zool., Pisc., v, 2, 1804, p. 456 = *Phyllopteryx foliatus* Swainson, 1839, from eastern Australia.

D.30; A.4; P.21; Annuli 17 plus 37. Sub-dorsal annuli 7.

Snout (43) 1·4 in head (62). Eye (7) 6·1 in snout or 8·9 in head. Postorbital (13) 3·3 in snout. Tail (121) 2·2 in total length of fish when extended (277). Depth at 10th body-ring (29) 2·1 in head.

Snout very long, three and one-third times postorbital, lacking processes below but with a pair of small spines on the upper surface two-thirds of its length

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[35] Jordan and Gilbert.—Proc. U.S. Nat. Mus., v, 1882, p. 648.

[36] This name is preoccupied by *M. helena* var. *fasciata* Meuschen, Index Zoophylac. Gronov., 1781, No. 164. Thunberg's species is *Chlevastes colubrina* (Boddaert).

[37] Jordan.—Gen. Fish., i, 1917, p. 53, and Smithson. Miscell. Coll., lxxiii, 4, 1926, p. 7.

[38] Jordan.—Gen. Fish., ii, 1919, p. 168.

[39] Smithson.—Miscell. Coll., lxxiii, 4, 1926, p. 7.

from the tip. A small preorbital spine and several serrations between it and the supraorbital spines, which are long and acute, the anterior pair pointing obliquely upwards and backwards and the posterior pair flaring outwards. A series of irregular serrations around orbit and two small spines below the eye at the vertical of the posterior supraorbital spines. Interorbital concave, pitted. Occiput elevated, with a leafy process. Opercles, nape, and top of head strongly granulated. A large blunt spine and several smaller ones in front of pectoral base. A long, slender, nuchal spine, bearing a process; a pair of similar, but curved, spines on the back between the tenth and eleventh body-rings and another pair on the ventral surface between the eighth and ninth body-rings. A short spinous bony plate on each side of the anterior rays of the dorsal fin. Two pairs of compressed spines, bearing each a leafy process, on top of tail. These and the ventral spines are very strongly serrated, more especially on their anterior edges. Three unpaired spines on the posterior half of the tail, the first two of which bear a leafy process; perhaps in the more elongated ancestors of *Phyllopteryx*, these spines, too, were paired and more separated than they are now, as there are traces of obliterated spines on the sides of the unpaired ones.

Body ridges with short, thorn-like spines, strongest along sides and ventral surfaces of body, but obsolete on dorsal arch, where there are numerous granulated ridges. Body strongly compressed, its width one-third of its depth. Upper profile evenly arched; lower profile convex anteriorly, concave behind the ventral spines, and gibbous before the anal fin. A hump in the dorsal outline on each side of the dorsal fin. The anterior part of the body forms a longer and thinner "neck" than is met with in *Phyllopteryx foliatus* (Shaw).

The colour-markings have faded in my specimen, which was received dry. The general tone is now horn brown becoming blackish under nearly all the tail and around its posterior portion. Snout, head, sides of abdomen, and dorsal surface of tail covered with yellow spots which are smaller than those of *P. foliatus*; the spots tend to become drawn out to form vertical bars on the end of the snout and are very small on the cheeks. Seven oblique violet bars on lower part of body between pectoral fin and ventral spine and a large dark blotch surrounding the small preanal spines.

Phyllopteryx lucasi is allied to *P. foliatus* (Shaw) from eastern Australia but is smaller, more slender, much more rugose on head and back, with more distinct and longer spines on the bony processes above tail and below thorax. The leafy processes are longer in the new species than they are in *P. foliatus* and the preanal dark spot is larger.

Described and figured from the holotype (Austr. Mus. No. IA.4119) which was found attached to some seaweed sent from Middleton Beach, Albany, Western Australia, to Mr. A. H. S. Lucas, M.A., B.Sc., to whom I have much pleasure in dedicating the species.

Family MYCTOPHIDÆ.

Genus **Lampanyctus** Bonaparte, 1840.

Lampanyctus piabilis sp. nov.

(Figure 1.)

Lampanyctus braueri Waite, Rept. Austr. Antarct. Exped., Zool. iii, 1, June 30, 1916, p. 61, figs. 14-14*a*. Macquarie Island. Not *Myctophum* (*Lampanyctus*)

brauerl Lönnberg, Schwedisch. Südpolar-Exped., v, 6, Fish., 1905, p. 64, fig. 1, from the South Atlantic Ocean. *Id.* Parr, Bull. Bingham Ocean. Coll., iii, 3, 1928, p. 78 (Antarctic ref. only). *Id.* Norman, Discovery Report ii, 1930, p. 327 (Macquarie Island record only).

D.18-19; A.18; P.13; V.8; C.19. L. lat. 42.

Depth (17 mm.) 5·7 in length to hypural joint (98). Head (28) 3·5 in same. Eye (7·5) 3·3 in the head.

Snout formed by a convex crest which bifurcates anteriorly. Preopercular crest very oblique above but vertical behind the maxillary. A band of villiform teeth in each jaw. Origin of the dorsal fin much nearer the snout than the base of the caudal and slightly behind the vertical of the first ventral ray; the length of its base is considerably longer than that of the anal fin and its posterior ray is over the fifth anal ray. Anal terminating just before the vertical of the adipose dorsal. Pectorals in the lower third of the depth, not reaching the ventrals. Ventrals reach origin of anal.

Photophores.—Two well-developed luminous glands on the anterior margin of the eye and within the orbital border, the upper above the nostrils and the lower at the antero-inferior margin extending backwards to below the pupil. One photophore is present behind the preopercular crest above the level of the maxillary; a second perhaps occurs lower down. A single thoracic is present anteriorly and is separated by a wide space from three equidistant pairs arranged near the median line of the ventral surface. A fifth pair is widely spaced, each being placed in front of the base of the first ventral ray. A photophore is situated just before the base

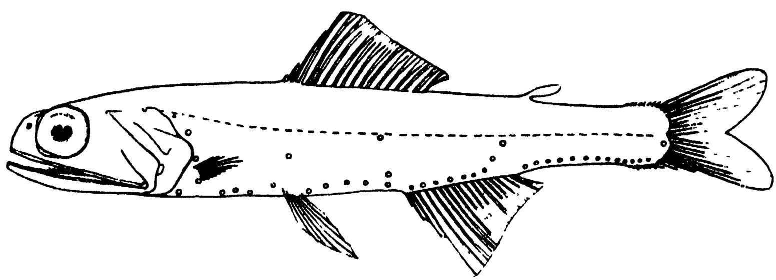

FIGURE 1.
Lampanyctus piabilis Whitley. Holotype from Macquarie Island.
(Ethel A. King, del.)

of the pectoral fin; two suprapectorals, one a little above the base of the pectoral fin and the other close to the lateral line, the two forming an oblique line bending forward and upward. Supra-ventral midway between the ventral fin and the lateral line. Five pairs of ventral photophores forming an evenly curved line on each side, the first and fifth being about equidistant from the median line and the fourth most widely separated. Apparently three supra-anals forming an oblique line, the lowest above the last ventral and the uppermost touching the lateral line a little in advance of the vertical of the anal origin. Seven or eight anal photophores forming a very slightly curved line, the last a little higher than the others: Waite's figure shows an elevated anteroanal above and slightly before the first of the lower series but all trace of this is lost in the specimens under review.

Two posterolaterals, the upper close to the lateral line, below the adipose dorsal. Posteroanal and lower precaudals forming a single row of thirteen photophores. A single precaudal behind the hypural joint, below the level of the lateral line. No photophores above the lateral line.

Described from two specimens 98 and 103 mm. in standard length. They are in imperfect condition, being denuded of scales and their fins are much broken. The photophores are imperfect in both, a number having been lost and no trace of their position remains. The accompanying figure represents the smaller specimen which is the holotype, though some details have been added from the larger paratype. These specimens are two of the three recorded from Macquarie Island by Waite as *Lampanyctus braueri*, but they differ from that species in several details. The dorsal fin has eighteen or nineteen rays and is longer than the anal instead of shorter as shown in Lönnberg's figure of *L. braueri*. There are two suprapectoral photophores instead of one and two well developed preocular luminous organs instead of a minute antorbital.

Locality.—Stranded on a beach at Macquarie Island, collected by the Australasian Antarctic Expedition, March 2, 1913. Holotype and paratype in Australian Museum, registered numbers IA.504 and 505 respectively.

Family HEMIRAMPHIDÆ.

Loligorhamphus, gen. nov.

Orthotype, *Loligorhamphus normani*, sp. nov.

The remarkable development of the cutaneous flaps below and on each side of the beak separates this genus at sight from all the other members of the family.

Loligorhamphus normani sp. nov.

(Plate xii, figs. 2 and 3.)

D.14; A.15; P.12; V.i/5; C.14. L. lat. *circa* 60. Br. 14.

Head, measured from tip of upper jaw (31 mm.), 4·1 in length from tip of upper jaw to hypural joint (127). Beak, measured from tip of upper jaw (59·5) 2·1, or entire lower jaw (66·5) 1·9 in same. Eye (7·5) 4·1, interorbital (8) 3·8, postorbital (11) 2·6 in head. Width of upper jaw (6) 1·3 in its length (8). Depth of body (12) 10·5, width of body (8) 15·1, width of head at opercles (9) 14 in standard length (127). Pectoral (16) 1·9, ventral (7·5) 4·1 in head, the latter fin equal to eye. Entire head (90) 2·2 in total length (198).

Head compressed, flat above. Eye large. Triangular part of upper jaw pointed and with a slight median keel, longer than broad. Preorbital rounded, scale-like, entire, with a subvertical groove before eye. Maxillary not entirely concealed. Opercles entire, operculum with a pointed flap. The nostrils occupy large basins, on the floor of which are two ridges diverging anteriorly. The nostrils themselves are in the form of a bunch of densely packed finger-like papillæ arranged in transverse rows. A band of minute pointed teeth on each intermaxillary is broadest anteriorly and separated from its fellow by a narrow symphysial interspace. A very much narrower band of similar teeth in lower jaw, not extending along beak. A buccal velum in both jaws. Beak elongate, tapering, with a narrow median groove formed by two bony rods extending the length of the beak. The main feature of this genus and species is the breadth attained by the folds of

skin on each side of the beak. Each lateral fold is broader than the beak itself. The width of the beak, with folds extended, is 10 mm., whilst that of the beak itself is only 4 at its base. On the chin, a pair of cutaneous folds coalesces on the median line and extends along the lower jaw apparently forming a closed tube. Branchiostegal rays fourteen. The left branchiostegal membrane overlaps the right and is joined to it and not to an isthmus. There are apparently no pseudobranchiæ. Gill-rakers slender, with small asperities anteriorly, about forty on lower portion of first gill-arch. A series of large pores around the top of each eye.

Body elongate, compressed, but flattened on dorsal and ventral surfaces, and tapering towards the tail. It had evidently been covered with large cycloid scales, but, owing to their deciduous nature, nearly all of these are now missing. From the scale-pockets it appears that there were about sixty scales along the lateral line, nine rows of scales between the dorsal and anal fins, forty-three predorsal scales, and about six rows of scales on each side of the caudal peduncle. Tubes of the lateral line straight, with a few short, simple, lateral branches. Vent a little in advance of anal fin. A small genital papilla.

Dorsal originating in advance of anal and terminating behind it. The first few rays appear to be simple and longest and the rest branched and shorter; the last two rays are markedly longer than those immediately preceding them. Anal with one short and spine-like ray and the rest branched; the anterior rays are longest and there are no produced posterior rays. Pectorals pointed, the upper rays longest, equal to distance from pupil of eye to opercular flap. Ventrals short, separate, originating much nearer base of caudal than base of pectoral. Caudal forked, the lower lobe apparently longer.

Colour, after long fixation in formalin and subsequent transference to alcohol, brownish above and lighter below. Beak and folds nearly all black, as are also the edges of the lowermost folds and areas on top of head and on operculum. Each scale-pocket on the back has a blackish mark but there are no definite lines running along the back. A blackish lateral stripe, probably silvery when the fish was alive, extends from the punctulated pectoral base to the base of the tail. It is broadest between the dorsal and anal fins. Fins without colour-marking, but there is a small amount of blackish pigment diffused over the dorsal and caudal.

Described and figured from the holotype, a specimen 127 mm. in standard length or 8½ inches in total length. Australian Museum registered number IA.2319.

Type locality.—Townsville, Queensland. Collected in October, 1924, by the late W. E. J. Paradice, Surgeon-Lieutenant of H.M.A.S. "Geranium," who supplied the following note on this species: "Caught at Townsville within the breakwater and some distance up the river. These fish swam round in pairs of at times up to six and sometimes in company with other species of garfish. Not seen outside the breakwater." Only one specimen, the type, is now in the Australian Museum.

Named in honour of Mr. J. R. Norman, of the British Museum, who has a second specimen.

The first garfish recorded from what is now Queensland was observed by Banks at Cooktown on July 4, 1770.

Family COBITIDÆ.

Enobarbichthys, gen. nov.

When I[40] proposed the generic name *Enobarbus* to replace *Jerdonia* Day 1870, preoccupied, I was unaware of a prior genus of birds said to have been named *Ænobarbus* by Temminck. I have not traced Temminck's original reference but quote from Gray's "Catalogue of the Genera and Subgenera of Birds," 1855, p. 54, No. 908, where the name appears to be published for the first time as there is no earlier introduction listed in Sherborn's "Index Animalium."

Thus a new name is required for *Jerdonia* Day, 1870, and *Enobarbus* Whitley, 1928, both preoccupied, and I propose as a substitute, *Enobarbichthys* with *Platacanthus maculatus* Day as orthotype; this species will now be known as *Enobarbichthys maculatus*.

Family CARANGIDÆ.

The Australian fishes of this family have been reviewed in part or as a whole several times, yet there still remains a great deal of work to be performed before the various species shall all have been correctly determined and placed in their proper genera. It seems likely that, when the geographical limits of the genera of Carangidæ are determined, the Australian forms so far called *Caranx* will be relegated to entirely different genera.

The tautotype of *Caranx* Lacépède[41] is *Caranx carangua* = *Scomber carangus* Bloch[42] from Martinique. Various authors have accepted other species as genotype and their action has led to some confusion. The generic name *Carangus* is merely a latinization of the French vernacular "les carangues" and is a synonym of *Caranx* Lacépède. Guichenot[43] seems to have been the first to use *Carangus* in the Latin sense.

Bleeker[44] proposed some new generic names on pages 342 to 344 in a list of species, defined the genera on page 352, and described the species later on. His names have, in some cases, been misquoted in Jordan's "Genera of Fishes," so I give here a list of the new Carangoid genera he proposed in that paper.

Bleeker, *loc. cit.*, p. 342,	*Megalaspis.*	Haplotype, *Caranx rottleri* Cuv. and Val.
	Decapterus.	Logotype, *Caranx kurra* Cuv. and Val.
" p. 343,	*Selar.*	Logotype, *Caranx boops* Cuv. and Val.
	Carangoides.	Logotype, *Caranx præustus* Raffles.
	Leioglossus.	Haplotype, *L. carangoides* Bleeker, p. 367.
	Selaroides.	Haplotype, *Caranx leptolepis* Cuv. and Val.

On page 160, Bleeker introduced *Gnathanodon*, with haplotype *Caranx speciosus* Cuv. and Val. [= Bonnaterre].

Regarding the genus *Atropus*, Sherborn quotes in his "Index Animalium": *Atropus* Oken, Isis, 1817, 1782 [= 1182] and *Atropus* H. R. Schinz in Cuvier,

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[40] Whitley.—Rec. Austr. Mus., xvi, June 11, 1928, p. 296.

[41] Lacépède.—Hist. Nat. Poiss., iii, 1802, p. 57. See also Jordan and Gilbert, Proc. U.S. Nat. Mus., vi, 1883, p. 192.

[42] Bloch.—Nat. ausl. Fische, vii, 1793, p. 69 (*fide* Sherborn).

[43] Guichenot.—Dict. pittoresque d'Hist. Nat., i, 1834, p. 634. Vernacular in Griffith, Anim. Kingd. (Cuvier), x, 1834, p. 196.

[44] Bleeker.—Nat. Tijdschr. Ned. Ind., i, 1851.

Thierreich, ii, 1822, 521 [*non* Cuvier *vernac.*]. This name is, however, preoccupied by *Atropos* Leach 1815, a genus of Orthoptera, also quoted by Sherborn. Oken's names in the "Isis," 1817, have been regarded as *nomina nuda* but *Atropus* Schinz, 1822, should apparently be regarded as a synonym of *Olistus* Cuvier[45] which Agassiz[46] emended to *Olisthus*. This genus is characterized by the filamentous median dorsal rays.

I wish to dispose of a *nomen nudum* in a formal manner by making *Caranx filigera* Saville-Kent[47] a synonym of *Citula gracilis* Ogilby.[48] The correct name of this species is *Citula oblonga*, originally described as a *Caranx*[49] but belonging to the genus *Citula* Cuvier, 1816.

Zamora, gen. nov.

Orthotype, *Caranx hullianus* McCulloch.[50]

The remarkable development of the dorsal and anal fins, whose median rays are longest, at once separates this species from any other genus of Carangidæ known to me. The type of *Zamora hulliana* is the only specimen known, and this has been described and figured by McCulloch in his usual complete manner.

Pantolabus, gen. nov.

Orthotype.—*Caranx parasitus* Garman.

Near *Alepes* Swainson[51] but with shorter pectorals and eye longer than snout. *Rastrum* Fowler[52] is also closely allied but the genotype has larger scales and longer pectoral fins than *Caranx parasitus*.

Pantolabus parasitus (Garman).

(Plate xii, fig. 1.)

Trichiurus[53] *declivis* Agassiz and Mayer, Bull. Mus. Comp. Zool. Harv., xxxii, April, 1898, p. 18. Cairns Harbour, Queensland; in medusa (*Crambessa mosaica*). Not *Caranx declivis* Jenyns, Zool. Beagle, Fish., 1841, p. 68.

Caranx parasitus Garman, Bull. Mus. Comp. Zool., xxxix, Aug., 1903, p. 232. Cairns, Queensland; in tentacles of medusa. Type in Mus. Comp. Zool., Harvard, U.S.A. *Id.* Jordan and Seale, Bull. U.S. Fish. Bur., xxv, 1906, p. 232. "Fiji" [= Queensland]. *Id.* McCulloch, Mem. Qld. Mus., viii, 1924, p. 68.

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45 Cuvier.—Règne Anim., ed. 2, ii, April, 1829, p. 209. *Genus cœlebs.*

46 Agassiz.—Nomencl. Zool., 1846, Index. Univ., p. 257.

47 Saville-Kent.—Prelim. Rept. Food-Fish. Qld., Govt. Printer, Brisbane, 1889, p. 10; Great Barrier Reef, 1893, p. 369. Queensland.

48 Ogilby.—Mem. Qld. Mus., iii, 1915, p. 75, pl. xxiii. Darnley Island, Queensland.

49 Cuvier and Valenciennes.—Hist. Nat. Poiss., ix, March, 1833, p. 128. Vanikoro, Santa Cruz Archipelago.

50 McCulloch.—Rec. Austr. Mus., vii, 4, Aug. 30, 1909, p. 319, pl. xci. Freshwater Beach, near Sydney, New South Wales. Type in Australian Museum.

51 Swainson.—Nat. Hist. Classif. Fish. Amphib. Rept., ii, July, 1839, pp. 176 and 248. Haplotype, *A. melanoptera* Swainson, based on "Wori Parah" Russell, Fish. Vizagapatam, 1803, pl. clv; specimen which had lost its scales.

52 Fowler.—Journ. Acad. Nat. Sci. Philad. xii, 1904, p. 509. Orthotype, *Alepes scitula* Fowler.

53 This is an error for *Trachurus declivis* which is correctly reported from Sydney Harbour, but the Cairns specimens are *Caranx parasitus* Garman. These were caught in Cairns Harbour, not on the Barrier Reef.

Id. Paradice and Whitley, *ibid.* ix, 1927, p. 82. *Id.* Fowler, Mem. Bish. Mus., x, 1928, p. 148. *Id.* McCulloch, Austr. Mus. Mem., v, 2, 1929, p. 187.

D.i (procumbent), viii, i, 22; A.ii, i, 19; P.21; V.i, 5; C.15. L. lat. 44 scutes. Br. 7-8.

Head (15 mm.) 3·3 in standard length (50). Depth at origin of second dorsal (21) 2·3 in same. Interorbital subequal to eye (5), 3 in head, and longer than snout (4). Pectoral (13) shorter than head.

Jaws subequal; maxillary broad, almost reaching to below middle of eye, with a supplemental bone. A narrow strip of minute villiform teeth in each jaw. No canines and no outer row of larger teeth. A velum in each jaw. A few microscopic teeth on vomer; apparently none on palatines. Tongue triangular, with a free rounded tip, edentulous. Eye large, with a narrow adipose margin posteriorly. Nostrils large, close together on each side of snout; the anterior nostril with a raised rim which becomes flap-like posteriorly. A strong occipital keel and two diverging ridges over eye. Cheeks scaly, rest of head entirely naked. Seven to eight branchiostegal rays. Some pores over the supraorbital ridge and alongside the occipital keel. Radiating mucus-tubes on preorbital and preoperculum. Gill-rakers not projecting into mouth.

Body compressed, deep anteriorly, but tapering to a slender caudal peduncle; the lower profile of the body more oblique posteriorly than the upper, so that the abdominal outline is more convex than that of the dorsal surface.

Small cycloid scales cover practically all of the body and extend on to the fin-sheaths but leave naked a small area on the breast anteriorly and do not extend far over the scapula. Base of pectoral and all head, except cheeks, entirely naked. The body scales are annulated and form wavy rows in some places where they are crowded on the flanks. Curve of lateral line ceasing below anterior rays of soft dorsal. About forty scales on curved part of lateral line, often with short, upwardly directed tubes; they are followed by about forty-four scutes on the straight portion of the lateral line. These scutes are small anteriorly but become largest as they approach the caudal peduncle, where they are less than one-tenth the height of the body, then they decrease rapidly in size to become very small on the tail.

Spinous dorsal preceded by several small crests and a procumbent spine. Anterior dorsal rays higher than spines, not forming a falciform lobe but with their margin rounded. No produced rays; last dorsal and anal rays not larger than or far apart from the others. Margins of dorsal and anal fins slightly excavate. Two uppermost rays of pectoral simple; the rest branched, third and fourth longest. Ventrals shorter than pectorals. Caudal forked, with rounded lobes.

Colour greyish above, sometimes with faint traces of darker shades along the myomeres. Sides brilliant silvery. The fins are whitish, except the spinous dorsal and tips of anterior dorsal rays, which are dusky, and the lobes and margins of the caudal which are black. The second dorsal is yellow in some specimens. A pronounced dark blue-black spot on operculum.

Described and figured from a specimen, 65 mm. in total length. Australian Museum registered number IA.4310, which is one of a series of six (IA.4201) collected by my friends Messrs. Melbourne Ward and William Boardman in Port Curtis, Queensland, where these fishes were swimming under a jellyfish

(*Crambessa*) in December, 1929. The species has not previously been figured and I am indebted to Miss Ethel A. King for the enlarged drawing here reproduced. There is also a young specimen, apparently referable to this species (IA.1544) in the Australian Museum from Pelican Spit, near Pellew Islands, Gulf of Carpentaria, also from a jellyfish; just over and behind each eye of this post-larva there is a dark patch of pigment cells whilst the black opercular spot, spinous dorsal, and tail-tips are characteristic. This specimen was captured by the late W. E. J. Paradice, who also secured specimens at McCulloch Reef, not far from Cairns, Queensland. The following note refers to these specimens.

"*Note from Dr. Paradice, Jan.*, 1925.—Young *Caranx* from medusa near McCulloch Reef (IA.2390) were taken from a large brownish species, which was soft, and with several very thick and particularly soft tentacles, from which depended also many slender stinging threads. The *Caranx* moved about freely beneath the Medusa but some crustaceans secured at the same time were not noticed until the jellyfish was laid upon the deck."

When the late A. R. McCulloch examined the north Australian specimen (IA.1544) he counted D.viii/22; A.iii/19 and Dr. Paradice recognized the jelly-fish from which it had been taken as *Crambessa mosaica* in Agassiz and Mayer's paper. Mr. McCulloch wrote to Dr. Samuel Garman asking for a specimen of his *Caranx parasitus* to be figured and received the following reply, which he had copied into his card-index.

"There are two specimens of *C. parasitus*, neither of which is particularly desirable for illustration, not exactly alike, both small, the larger 2¾ inches; both have the round spot of black on the opercle. On both, the first dorsal is black and the second dorsal is black-edged; the caudal is edged with black, wider posteriorly. The general colour is yellowish thickly sprinkled with multitudes of minute black dots, except below the pectoral in a triangular space of silvery. Number of fin-rays, scales, and shape of body like *C. chrysos*. Lateral line straight from a point below the foremost rays of the soft dorsal; all of its scales comparatively small. Maxillary extending slightly below orbit. Have compared *C. georgianus* with *C. parasitus* and others, but find no adult of the latter. Am sorry we have not the duplicates for which you inquire."

Pantolabus parasitus is easily distinguishable from all the other Australian species of *Caranx* (sensu latissimo) by the rounded dorsal and anal lobes, the abdominal profile more convex than the dorsal arch, the short pectorals, and by the rounded, heavily-pigmented caudal lobes. The dark opercular spot is characteristic; the eye is longer than the snout and the breast is almost entirely scaly in *P. parasitus*.

The nearest ally of this species is *Alepes kalla* Cuvier and Valenciennes[54] of which Ogilby[55] has figured the Queensland form, *A. kalla queenslandiæ* (De Vis).

The following key will differentiate Garman's species.

Height more than 3 times in total length. Last dorsal and anal ray longer than and separated from the others. Pectoral long, falciform. L. lat. scutes one-seventh height of body, broadest under soft dorsal fin .... *Alepes kalla*.

Height about one-third of total length. Last dorsal and anal ray not longer than or separated from the others. Pectoral short, rounded. Scales small; the l. lat. scutes not nearly one-seventh height of body, broadest near caudal peduncle .... *Pantolabus parasitus*.

Cases of commensalism between Carangoid fishes and medusæ and other jelly-fishes have frequently been commented upon; perhaps the best known case being

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[54] Cuvier and Valenciennes.—Hist. Nat. Poiss., ix, March, 1833, p. 49. Pondicherry; as *Caranx*, and on p. 51 as *Scomber bimaculatus*, a *nomen nudum*.

[55] Ogilby.—Mem. Qld. Mus., iii, 1915, p. 62, pl. xx.

that of the Portuguese Man-o'-War Fish (*Nomeus albula*) which is found with *Physalia*. In England[56] young Whiting (*Gadus merlangus*) have been found under the stinging jellyfish (*Cyanea*). References to literature on this subject are given by Dean,[57] but I may add that Semon[58] has recorded *Caranx auratus* and *C. hasselti* as being symbiotic with medusæ.

Family CHÆTODONTIDÆ.

Genus Microcanthus Swainson, 1839.

Microcanthus Swainson, Nat. Hist. Classif. Fish. Amphib. Rept., ii, July, 1839, pp. 170 and 215. Haplotype, *Chætodon strigatus* Cuv. and Val.

Therapaina Kaup, Arch. Naturg. (Wiegmann), xxvi, 1, 1860, p. 140. Orthotype, *Chætodon strigatus* Cuv. and Val. *Id.* Bleeker, Ned. Tijdschr. Dierk., iv, 1873, p. 140, and Arch. Neerl. Sci. Nat., xi, 2, 1876, p. 298 (*fide* Jordan, Gen. Fish., 1919, and Weber and Beaufort, Fish. Indo-Austr. Archip., 1911).

Neochætodon Castelnau, Proc. Zool. Acclim. Soc. Vict., ii, May 10, 1873, p. 130. Haplotype, *N. vittatum* Castelnau.

Micracanthus Jordan, Gen. Fish., ii, 1919, p. 198. Emendation for *Microcanthus*, "a wilful misprint for *Micracanthus*." Not *Micracanthus* Sauvage 1879 = *Oshimia* Jordan 1919, a genus of Osphromenid fishes (*vide* Gen. Fish., iii, 1919, p. 400).

Microcanthus joyceæ sp. nov.

(Plate xiii, figs. 4 and 5.)

Chætodon strigatus Steindachner, Sitzb. Akad. Wiss. Wien, liii, 1866, p. 435 (Port Jackson). *Id.* Schmeltz, Mus. Godef. Cat., vii, 1879, p. 42. *Id.* Ogilby, Cat. Fish. N. S. Wales, 1886, p. 16 (Clarence R.). Not *C. strigatus* Cuv. and Val.

Chætodon (*Microcanthus*) *strigatus* Waite, Rec. Austr. Mus., vi, 1905, p. 65.

Microcanthus strigatus Cockerell, Mem. Qld. Mus., iii, 1915, p. 43 (Queensland; scales described). *Id.* McCulloch, Biol. Res. Endeavour, iv, 4, 1916, p. 193. *Id.* McCulloch, Austr. Zool., ii, 3, 1922, p. 91; Check-List Fish. N. S. Wales, 1922, p. 65 (not fig.). *Id.* Ahl, Archiv. Naturg. lxxxix, A., 5, 1923, p. 22. *Id.* McCulloch, Austr. Mus. Mem., v, 2, 1929, p. 248.

D.xi/17; A.iii/14; P.i/15; V.i/5; C.15. Sc. 52. L.tr. 35.

This new species is the fish, vernacularly known as the Stripey in New South Wales, which has hitherto been identified as *Chætodon strigatus* Cuvier and Valenciennes[59] which is a Japanese species. Although it agrees well with the description of Japanese specimens given by Jordan and Fowler,[60] the eastern Australian form may be distinguished by its smaller size and differently disposed dark bands. The holotype of *Microcanthus joyceæ* is a specimen 87 mm. in standard length or about 4¼ inches in total length and is one of a series collected at Shell Harbour, New South Wales, by Mr. F. A. McNeill in March, 1924 (Austr.

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[56] Russell and Yonge.—The Seas, 1928, p. 82.
[57] Dean.—Bibliogr. Fishes, iii, 1923, p. 395.
[58] Semon.—Rumphius Gedenkboek, 1902, p. 96.
[59] Cuvier and Valenciennes.—Hist. Nat. Poissons, vii, April, 1831, p. 25, pl. clxx. Ex Langsdorff MS.
[60] Jordan and Fowler.—Proc. U.S. Nat. Mus., xxv, 1902, p. 541.

Mus. registered number IA.4012). Cuvier and Valenciennes' figure of the typical *M. strigatus* shows a fish eight inches long; *M. joyceæ* only attains a length of about six inches and is generally smaller. The differences in colour-marking between the two may be best appreciated by comparing the accompanying figure with the illustrations given by Cuvier and Valenciennes and Temminck and Schlegel.[61]

Range.—Southern Queensland and New South Wales.

Named in honour of Miss Joyce K. Allan of the Australian Museum, to whom I am indebted for the excellent illustrations of this species.

Microcanthus vittatus (Castelnau).

(Plate xiii, fig. 3.)

Neochætodon vittatum Castelnau, Proc. Zool. Acclim. Soc. Vict., ii, May 10, 1873, p. 130. Fremantle district, Western Australia.

Chætodon strigatus Waite, Rec. Austr. Mus., iv, 1902, p. 189 (Pinjarrah, W.A.). *Id.* Woodward, W. Austr. Year Book, 1900-1 (1902), p. 270. Not *C. strigatus* Cuv. and Val.

Microcanthus strigatus Alexander, Journ. Linn. Soc. Lond., Zool., xxxiv, 1922, p. 482 (Houtmans Abrolhos, W.A.).

The "Footballer" of Western Australia is a close ally of the Stripey of the east but differs in the form of the band which extends from the pectoral to the anal. Whereas in *M. joyceæ* this band is not interrupted by any bend or angle, in *M. vittatus*, its western congener, there is a definite kink giving an angular effect just above the anal spines. Also in *M. vittatus* the ends of the bands which extend on to the anal fin are somewhat expanded. I have examined eight specimens of *M. vittatus* in the Australian Museum which were collected in Western Australia by A. Abjornssen many years ago.

Range.—Western Australia.

Microcanthus howensis sp. nov.

(Pl. xiii, fig. 2.)

Chætodon strigatus Ogilby, Austr. Mus. Mem., ii, 1889, p. 55 (7 of reprint). Lord Howe I. Not *C. strigatus* Cuv. and Val.

Microcanthus strigatus Waite, Rec. Austr. Mus., v, 1, 1903, p. 37, and v, 3, 1904, p. 215.

Specimens from Lord Howe Island hitherto identified as *M. strigatus* are characterized by very narrow stripes. As coloration is evidently of specific value in this genus, I name the Lord Howe Island form *Microcanthus howensis*. The type is No. IA.4018 in the Australian Museum. In this specimen, which is 51 mm. in standard length or a little over 2⅛ inches long, the dark bands are narrower than their interspaces and only extend about half-way across the soft dorsal and anal fins.

Range.—Lord Howe Island.

The similarity in external appearance and facies between *Microcanthus* and the Scorpid "Mado" (*Atypichthys*) in New South Wales and Lord Howe Island is worthy of notice, though an explanation of it is not forthcoming.

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[61] Temminck and Schlegel.—Faun. Japon., Poiss., 1844, p. 80, pl. xli, fig. 1.

Hitherto the genus *Microcanthus* has been regarded as monotypic, the species *M. strigatus* having been credited with a very wide range. Whilst separation into species or sub-species is admittedly difficult, I am inclined to think that comparison of specimens from different localities would show that even more forms may later be separable. The species described and figured as *Microcanthus strigatus* by Herre and Montalban[62] from Amoy and Hong Kong is said to have pectorals and caudal light brown and, as the upper dark bands are very broad in the figure, it seems probable that the Chinese form may have to receive a new name.

Without specimens, I am unable to satisfy myself as to the identity of the *Microcanthus strigatus* of Hawaiian waters, which may be another species. The following are the chief references to literature on this form.

Chætodon strigatus Günther, Journ. Mus. Godef., ii (Fische Südsee, i), 1873, p. 47. Sandwich Is. Perhaps not *C. strigatus* Cuv. and Val.

Microcanthus strigatus Jordan and Evermann, Bull. U.S. Fish. Comm., 1903, i (1905), p. 376. *Id.* Fowler, Mem. Bish. Mus., x, 1928, p. 256, pl. xxviii, fig. *a*.

Micracanthus strigatus Jordan and Jordan, Mem. Carneg. Mus., x, 1, 1922, p. 61.

Family CORIDÆ.

Halinanodes, gen. nov.

Orthotype, *Halichœres leucostigma* Fowler and Bean.

Head naked. Dorsal and anal bases without scaly sheaths. Less than seventeen dorsal rays. No black ocelli, stripes, or bands on body nor black spots on anal fin, but a median row of large silvery or light-coloured spots along sides.

Halinanodes leucostigma (Fowler and Bean).

Halichœres leucostigma Fowler and Bean, Bull. U.S. Nat. Mus., 100, vii, 1928, pp. 253 and 299, pl. xl. Mindanao, Philippine Is. Type in U.S. Nat. Mus.

Mr. Arthur A. Livingstone collected a specimen of this little-known species in a rock-pool at East Point, Port Darwin, North Australia on 20th June, 1929. This is the only specimen known besides the type and therefore constitutes a new record for Australia. Mr. Livingstone noted the colours as follows: "From top of gills to base of tail, two-thirds distance down body from base of dorsal fin, light brown with large, regularly spaced spots of sea-green. Rest of body greenish-yellow. Dorsal fin indian red with large greenish yellow spots. Top half of head with wide purple lines edged with blue, also yellowish green lines edged with blue. Ventral fins and tail same colour-markings as dorsal fin. Extreme top and bottom tips of tail bright yellow. Body with nine silverish spots arranged in two lines on distal half of body." Four spots on one side and five on the other, on the median line. Australian Museum registered number IA.4288.

Genus **Anampses** Quoy and Gaimard, 1824.

Anampses Quoy and Gaimard, Voy. Uran. Physic., Zool., 1824, p. 276. *Ex* Cuvier MS. Haplotype, *A. cuvier* Quoy and Gaimard. *Id.* Quoy and Gaimard, Ann. Sci. Nat., iii, 1824, p. 419 (9 of reprint). *Id.* Cuvier, Règne Anim. ed. 2, ii, April, 1829, p. 259. *Id.* Cuvier and Valenciennes, Hist. Nat. Poiss. xiv,

[62] Herre and Montalban.—Philipp. Journ. Sci., xxxiv, 1, 1927, p. 72, pl. xviii, fig. 1.

"1839" = Jan., 1840, p. 3. *Id.* Fowler and Bean, Bull. U.S. Nat. Mus., 100, vii, 1928, pp. 189 and 224.

Anampsis Swainson, Nat. Hist. Classif. Fish. Amphib. Rept., ii, July, 1839, pp. 173 and 233. Error. Type, by present designation, *A. cuvieri* Swainson = *Anampses cuvier* Quoy and Gaimard.

Distinguished from the following genus by having thirty or less scales in the lateral line, instead of about fifty.

Genus **Pseudanampses** Bleeker, 1862.

Pseudanampses Bleeker, Atlas Ichth., i, 1862, p. 101. *Genus cœlebs.* Logotype, *Anampses geographicus* Cuv. and Val., by present designation.

Ampheces Jordan and Snyder, Proc. U.S. Nat. Mus., xxiv, May 2, 1902, p. 628. Orthotype, *Anampses geographicus* Cuv. and Val.

In the text of his "Atlas Ichthyologique," Bleeker proposed the name *Pseudanampses* for the non-typical species of *Anampses* Cuvier having a different number of scales and differently formed canines in the lower jaw. Bleeker's generic name seems to have been generally overlooked and, as he does not appear to have designated a genotype, I select *Anampses geographicus* Cuvier and Valenciennes[63] as the logotype of *Pseudanampses*. *Anampses cuvier* Quoy and Gaimard, from Hawaiian Islands, has less than thirty scales on the lateral line, and is the typical *Anampses*. Bleeker's *Pseudanampses* therefore obviously applies to the species with about fifty lateral scales. By designating *Anampses geographicus* the logotype of Bleeker's genus, *Ampheces* Jordan and Snyder is made an absolute synonym of *Pseudanampses*.

Family CHEILINIDÆ.

Genus **Cheilinus** Lacépède 1802.

Cheilinus fasciatus (Bloch).

Sparus fasciatus Bloch. Nat. ausl. Fische v, 1791, p. 18 (*fide* Sherborn, Index Anim.); Ichtyologie, iv, 8, 1797, p. 15, pl. cclvii. "Japan" = East Indies. *Id.* Shaw, Gen. Zool., iv, 2, 1803, p. 412. Japan. *Id.* Shaw and Nodder, Nat. Miscell., xviii, 1806, pl. dcclv. "American and Indian Seas" = East Indies.

Labrus enneacanthus Lacépède, Hist. Nat. Poiss., iii, 1802, pp. 433 and 480. Locality unknown; probably East Indies.

Sparus bandatus Perry, Arcana, Feb., 1810, eighth plate. "The Eastern Ocean."

Cheilinus fasciatus Cloquet, Dict. Sci. Nat., viii, 1817, p. 344. *Id.* Bleeker, Atl. Ichth., i, 1862, p. 67, pl. xxvi, fig. 2. *Id.* Whitley, Abstr. Proc. Linn. Soc. N. S. Wales, No. 429, Sept. 27, 1929; and Proc. Linn. Soc. N. S. Wales, liv, 6, 1930, p. 1.

Status of Sparus bandatus *Perry.*—The rarity of Perry's "Arcana" is responsible for the fact that most ichthyologists have overlooked the names of fishes proposed therein. A résumé of the contents of this book was given by Mathews and Iredale,[64] but since their account was written, the Australian Museum library has acquired a copy, upon which the following notes are based. *Sparus bandatus*

[63] Cuvier and Valenciennes.—Hist. Nat. Poiss., xiv, "1839" = Jan., 1840, p. 10, pl. ccclxxxix. No locality (probably Amboina).

[64] Mathews and Iredale.—Victorian Naturalist, xxix, 1, 1912, pp. 7-16.

is the name given by Perry to a species whose illustration is so similar to the figures of Shaw and Nodder and of Bloch as to allow of no doubt that it is conspecific with *Sparus fasciatus* Bloch; indeed, one suspects that the figure has been copied.

A list of the Fishes in Perry's "Arcana" is as follows:

Feb., 1810. Plate [viii]. *Sparus bandatus*, nov. The Eastern Ocean.
1 Apr., 1810 [xiii]. The Dolphin. (No scientific name.) Specimen from Bullock's Museum. European Seas.
1 May, 1810 [xviii]. *Syngnathus* or *Hippocampus foliatus*. Botany Bay.
July, 1810 [xxvi]. *Stromateus depressus*, nov. No locality. *Ex* Willshire collection.
1 Dec., 1810 [xlv]. *Syngnathus* or *Hippocampus erectus*, nov. American Seas and the coasts adjacent to Mexico and the West Indies.
1 Feb., 1811 [lv]. *Congiopodus percatus*, nov. No locality.
1 March, 1811 [lxii]. *Esox niloticus*, nov Nile.
1 August, 1811 [lxxix]. *Zeus faber*. Coasts of Europe.

I have not been able to determine all Perry's species but offer the following notes and references. *Sparus bandatus* = *Cheilinus fasciatus* (Bloch). "The Dolphin" = *Coryphæna hippurus* Linné. McCulloch[65] has discussed the status of the Botany Bay seahorse (*Phyllopteryx foliatus*). *Stromateus depressus* = *Selene vomer* (Linné); the type locality may be designated America. *Syngnathus* or *Hippocampus erectus* Perry is an American *Hippocampus* and Perry's illustration has apparently been copied by Goldsmith and reproduced by Osburn.[66] A note on *Congiopodus* was given by McCulloch.[67] *Esox niloticus* is apparently a species of *Lepisosteus*, whilst *Zeus faber* Linné is the well-known John Dory. "*The Fishing* CORMORANT *of China*" is also mentioned in the "Arcana."

Family CALLIONYMIDÆ.

Yerutius, gen. nov.

Orthotype.—*Callionymus apricus* McCulloch.[68]

Yerutius apricus (McCulloch) is a deep-water form belonging to the same family as *Callionymus* Linné[69] but characterized by having very large eyes, preopercular spine curved upward distally and without an antrorse spine below it, no broad ventral membrane covering bases of lower pectoral rays, dorsal rays branched, head and body not depressed.

This new genus also includes *Callionymus phasis* Günther[70] and *C. rubrovinctus* Gilbert,[71] although the latter may be subgenerically distinct as it has simple dorsal rays and a ventral membrane.

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65 McCulloch.—Rec Austr. Mus., xv, 1, 1926, p. 28.

66 Osburn.—Zool. Soc. Bull., xviii, 2, 1915, p. 1211.

67 McCulloch.—Rec. Austr. Mus., xv, 1, 1926, p. 37.

68 McCulloch.—Biol Res. Endeavour, v, 4, June 8, 1926, pp. 196 and 209, pl. liv, fig. 2. Great Australian Bight; 350-450 fathoms. Holotype on deposit in Austr. Mus. Name mis-spelt *C. africus* in Zool. Record.

69 Linné.—Syst. Nat, ed. 10, 1758, p. 249; ed. 12, 1766, p. 433. Logotype, *C. lyra* Linné.

70 Günther.—Rept. Voy. Challenger, Zool. i, 6, 1880, p. 28, pl. xv, fig. *c*. Twofold Bay, New South Wales. Type in British Museum.

71 Gilbert.—Bull. U.S. Fish. Comm., xxiii, 2, Aug. 5, 1905, p. 650, fig. 252. Hawaiian Islands. Type in U.S. Nat. Mus.

Family PLATYCEPHALIDÆ.

Genus **Neoplatycephalus** Castelnau, 1872.

Neoplatycephalus castelnaui (Macleay).

(Plate xiii, fig. 1.)

Platycephalus castelnaui Macleay, Proc. Linn. Soc. N. S. Wales, v, 4, May 20, 1881, p. 587. King George's Sound, Western Australia. Holotype in Macleay Museum, University of Sydney.

The following description is from some unpublished manuscripts of the late Allan R. McCulloch.

D.viii-ix/14; A.14; P.19; V.i/5; C.11-13. L. lat. 85.

Head 3·25-3·30 in the length to the hypural; the cranial ridges very low, scarcely visible beneath the skin, without spines. Eye without tentacles, 5-5·66 in the head, and 1·30-1·53 in the snout, which is 3·7-3·82 in the head. Interorbital space a little concave, 1·57-2 in the eye. Maxillary reaching to below the anterior margin of the pupil. Bony stay of cheek with two slight elevations but without spines; preoperculum with two acute, diverging spines of subequal length. A broad band of villiform teeth in the upper jaw with some canines on either side of the symphysis; three or four rows of very small teeth on the front portion of the lower jaw, which change into a single row of canines on the sides. Vomer with an arched band of teeth, those of the middle part minute and in a single row, while on each side they form a cluster of several canines. Palatines with a row of canines and some smaller teeth at their bases.

Scales rather small, ctenoid, extending on to the head as far as the hinder margins of the eyes, those of the lateral line are similar to the others. There are about 115 rows just above the lateral line. Caudal rounded.

Sandy coloured or greyish with about five indefinite darker crossbands. Head and back closely dotted with black, cheeks with a series of about eight dark blotches between the bony ridges. All the fins, except the anal, with more or less distinct darker spots, the caudal also with a black blotch posteriorly.

Described from three specimens, 257-325 mm. long, including the type. The Australian Museum contains three which were collected by Mr. A. Abjornssen near Albany, one of which (No. I.11453) is figured here, and I have examined one from the Western Australian Museum from the same locality.

According to Macleay's description, this species is scaly to the muzzle, the width of the head between the preopercular spines is about one-fourth of the total length, the eye is scarcely twice in the snout, and there are about eight quadrangular depressions between the bony ridges of the cheek. None of these characters is found in the specimen which is labelled as his type, nor in any others I have seen from the same locality. In the type, the width of the head is 1·7 in its length and 5·6 in the length to the hypural. The eye is 1·43 in the snout. What Macleay possibly supposed to be scales between the eyes and to the muzzle are really minute elevations surrounding pores in the skin, while the so-called depressions on the cheeks are quadrangular brown marks similar to those found in many species of Platycephalidæ.

Family GLYPTAUCHENIDÆ.

Genus Glyptauchen Günther, 1860.

Glyptauchen Günther, Cat. Fish. Brit. Mus., ii, June, 1860, p. 121. Haplotype, *Apistus* (sic) *panduratus* Richardson. *Id.* Regan, Ann. Mag. Nat. Hist., (8) xi, 1913, p. 170. *Id.* Jordan, Gen. Fish., ii, July, 1919, p. 296, and Classif. Fish., 1923, p. 210.

Goblin Fishes are aptly so named on account of their grotesque and almost hideous appearance. These members of the genus *Glyptauchen* belong to an order of fishes, the Cataphracti, which includes such bizarre forms as *Synanceja*, *Pterois*, *Patæcus*, and *Platycephalus*. Goblin Fishes have the forehead almost vertical, the mouth small, and the occipital region so concave that it seems as if it had been excavated by unnatural means.

Unfortunately, these remarkable Goblin Fishes are very rarely captured and nothing seems to be known regarding their habits. They are probably sedentary, carnivorous fishes of the rocky zone beyond tidal limits, and it is probable that their preorbital and dorsal spines could inflict painful wounds. The largest specimen of *Glyptauchen* on record is only eight inches in length.

This genus is unknown outside Australia, and as it is quite unlike *Scorpæna* or *Synanceja*, with which the earlier authors grouped it, *Glyptauchen* may be regarded as typical of a new family, the Glyptauchenidæ.

This genus, which has hitherto been regarded as monotypic, may be divided into the following specific and subspecific groups each typical of a well-marked zoogeographical region.

Glyptauchen panduratus (Richardson).

Apistes panduratus Richardson, Proc. Zool. Soc. Lond., Nov. 12, 1850, p. 58, Pisces pl. i, figs. 3 and 4. King George's Sound, West Australia (Neill). [Location of type unknown.] *Id.* Richardson, Ann. Mag. Nat. Hist., (2) vii, April 1, 1851, p. 274.

Glyptauchen panduratus Günther, Cat. Fish. Brit. Mus., ii, 1860, p. 121. *Id.* Macleay, Proc. Linn. Soc. N. S. Wales, v, 3, Feb., 1881, p. 434, and Descr. Cat. Austr. Fish., i, 1881, p. 134. *Id.* Woodward, W. Austr. Year Book, 1900-1 (1902), p. 271 (listed only). *Id.* McCulloch, Austr. Mus. Mem., v, 1929, p. 391.

The typical form of this species is Western Australian. Critical study of specimens and literature leads me to believe that there are two species confused by authors who have regarded all the Australian forms as conspecific. The eastern Australian form is obviously a new species and is fully described and figured here, but Tasmanian and South Australian specimens identified as *Glyptauchen panduratus* are evidently deserving of subspecific separation.

Glyptauchen panduratus deruptus subsp. nov.

Glyptauchen panduratus Castelnau, Proc. Zool. Acclim. Soc. Vict., i, 1872, p. 244 and *ibid.*, ii, 1873, p. 62 (St. Vincent's Gulf, South Australia). *Id.* Waite, Rec. S. Austr. Mus., ii, 1, 1921, p. 167, not figure. *Id.* Waite, Fish. S. Austr., 1923, p. 192, not figure. Not *Apistes panduratus* Richardson, 1850.

This is the South Australian Goblin Fish which has been well described by Castelnau. It cannot, however, be the true *Glyptauchen panduratus* as Castelnau

describes the height of the dorsal fin as being equal to two-thirds the height of the body and the length of the base of the second dorsal as not one-fifth that of the spinous part. The pectoral fins are said to go two and a half times in the total length of the fish. These differences are sufficient to merit subspecific distinction, and the South Australian form many therefore be called *Glyptauchen panduratus deruptus*, the type-locality being St. Vincent's Gulf.

Glyptauchen insidiator sp. nov.

(Plate xiv.)

Glyptauchen panduratus Ogilby, Cat. Fish. N. S. Wales, publ. Aug., 1886, p. 21 and Rept. Comm. Fish. N. S. Wales, 1886 (1887), append. A., p. 21 (Port Jackson record only). *Id.* Waite, Mem. N. S. Wales Nat. Club, ii, Nov., 1904, p. 47 (listed only). *Id.* Stead, Abstr. Proc. Linn. Soc. N. S. Wales, Oct. 25, 1905, p. iii; Proc. Linn. Soc. N. S. Wales, xxx, April, 1906, p. 486 (South Reef, Port Jackson Heads), and Fishes Austr., 1906, pp. 191 and 195, fig. 68. *Id.* McCulloch, Austr. Zool., ii, 3, 1922, p. 117, not figure. Not *Apistes panduratus* Richardson, 1850.

Br. 7. D.xvii/7; A.iii/5 (last divided); P.14-15; V.i/5; C.10. 27-28 tubes in l. lat. About 30 transverse series of scales between scapula and root of caudal.

Head (41 mm.) 2·48 in length to hypural joint (102). Depth (36) 2·83 in same. Eye (11·5) equal to supraorbital width (11·5). Preorbital spine (8·5) not so long as upper preopercular spine (9). Longest (ninth) dorsal spine (21) almost 2 in head. Height of soft dorsal (19) less than that of anal (21·5); both less than length of caudal (26).

Profile of head almost vertical over mouth, subhorizontal over eye, and squarely excavated on occiput. Back and belly evenly convex. Head entirely naked, much longer than high and longer than broad. Two almost vertical nasal spines on the snout end in two knobs above, and are separated by a narrow furrow. The supraorbitals overhang the eyes and have strong spineless ridges superiorly. Two similar ridges on the interorbital area are separate anteriorly and diverge posteriorly to join a transverse series of irregular ridges behind the eye. The saddle-shaped occipital depression is crossed by two low longitudinal ridges. Preorbital armed with a small anterior and a large posterior spine. The latter is erectile and is attached to the spine at the commencement of the strong, irregular but spineless, suborbital ridge. Two large nostrils, each with a flap, before the eye; the lower pair a trifle in advance of the upper. Eye large. Mouth small, the maxillary reaching to below the anterior third of the eye. A broad dermal flap depends from each side of the mandible. Villiform teeth in jaws and on vomer and palatines. Palatine velum present.

Preoperculum with a series of five spines along its margin. The lower spines are short and triangular, but the uppermost is very long and strong and has a small spine at its base. Two long curved spines on operculum. Two pairs of short, strong, curved spines on each side of the origin of the dorsal fin; the posterior spines are strongest and are striated. The broad opercular flap overlies the base of a strong oblique scapular spine. Branchiostegals seven, the sixth and seventh small and close together. Gill-membranes free, united across isthmus.

Body compressed, with the back elevated. Below the dorsal fin the skin is naked, smooth anteriorly, and plicated posteriorly and towards the scaly sides.

The thorax is scaleless in advance of a line drawn from the origin of the lateral line to the attachment of the last ventral ray and the breast is naked in advance of a line connecting the origins of the last ventral rays. The sides of the body are covered with large, rounded, imbricate, deciduous, cycloid scales which do not extend on to the head or fins and leave naked the space between the vent and the anal fin. The lateral line is marked by a series of tubes, each with a posterior rounded flap, except on the caudal peduncle, where the pore-like opening of each tube is not thus protected.

Dorsal originating behind the occipital concavity and extending almost to the root of the caudal. The ninth dorsal spine is the longest and the margin of the spinous fin is evenly convex. The soft dorsal is high anteriorly, but the last ray is only about one-half the length of the first, and the second ray is longer than the others. Length of base of soft dorsal about one-sixth that of spinous portion. Anal with three spines, the second strongest and subequal to third. Soft portion of anal similar to that of dorsal fin. Pectorals large, rounded, not so long as the head; their fourth or fifth rays are longest and the lowermost rays are very short. All the pectoral rays are branched but the tips of the lowermost rays form finger-like lobes. Ventrals broadly rounded, not nearly so long as pectorals, and with fewer lobe-like branches to their rays. The base of attachment is broad and the origin of the ventral spine is below that of the fifth dorsal spine. Caudal unevenly rounded, the bases of the rays crowded.

After preservation in alcohol, the general colour of the body and fins is blackish, with the light parts of the fins and caudal peduncle light yellowish. Some scattered white spots on first dorsal fin and two small white blotches on the back. Head brownish above, yellowish below, mottled on mouth and around eye. The red colour of the eye and the rosy mark on each operculum have almost faded, yet these colours were most prominent in life. The breast and pectoral axilla are yellowish, suffused with a tinge of brownish. Over the root of the pectorals and extending obliquely for a short distance up the sides, there is a white mark, somewhat similar to the whitish patches formed when scales are rubbed off the sides. Ventrals and pectorals dark brownish; some whitish mottling on upper pectoral rays.

Described and figured from the holotype of *Glyptauchen insidiator*, a specimen 102 mm. in standard length, or 5½ inches in total length. Australian Museum registered number IA.4634. This specimen was caught at Kurnell, Botany Bay, New South Wales, at the end of June, 1930, by Mr. G. W. Dare. It was kept in a lobster-pot, in which it had been caught, for a fortnight, and was then brought to the Museum alive. Sandy worm-tubes were noticed on its erect spinous dorsal fin, on the nape, and over one eye; the construction of these must have taken some time and their presence indicates that the Goblin Fish is of sedentary habits, probably lying practically motionless for hours, or perhaps for days. I have also noticed a galeolarian worm-tube on the head of another curious sedentary local fish (*Aploactis milesii*).

The accompanying plate was painted from the living specimen by Miss Ethel A. King.

Glyptauchen insidiator is allied to *G. panduratus* but differs at sight from Richardson's figure in having a much more arched back, deeper body, shorter anterior dorsal spines, fewer and smaller preopercular spines, and differently arranged colour pattern. Richardson's figure shows three distinct spines on each

side of the origin of the dorsal fin whereas *G. insidiator* has only two. The Western Australian type appears to have a shorter supraorbital ridge and a narrower head than my eastern form. The seventh dorsal spine is longest in *G. panduratus* whereas the ninth is the longest in *G. insidiator*. Several minor differences are also noticeable when Richardson's excellent account is checked with my holotype, which is only ⅜ in. shorter than his specimen.

Glyptauchen insidiator mirandus subsp. nov.

Glyptauchen panduratus Johnston, Proc. Roy. Soc. Tasm., 1882 (1883), p. 114, and *ibid.* 1890 (1891), p. 31. (Listed from Tasmania). *Id.* Lord, Proc. Roy. Soc. Tasm., 1922 (1923), p. 70, and Journ. Pan. Pacif. Res. Inst., ii, 4, 1927, p. 15. *Id.* Lord and Scott, Syn. Vert. Tasm., 1924, p. 85. Not *Apistes panduratus* Richardson, 1850.

The Tasmanian form of *Glyptauchen* agrees in general with the descriptions of *G. panduratus* and *G. insidiator* but an Australian Museum specimen has the following characters, which suggest that the southern Goblin Fish should at least be regarded as a new subspecies.

D.xvii/7; A.iii/5(6); P.14; L. lat. 27. About 40 transverse rows of scales between scapular spine and hypural joint. Head (53 mm.) 2·8, depth (55) 2·7 in length to hypural joint (150). Longest (ninth) dorsal spine (29) 1·8 in head.

The nasal spines end in sharp points above. The transverse ridges joining the supraorbital ridges form an oblique shelf which overhangs the occipital concavity and is not vertical as in *G. insidiator*, s. str. The anterior spines on each side of the dorsal fin are almost divided, so that each has two points.

Length of base of soft dorsal fin about one-quarter that of the spinous. Height of spinous dorsal fin about half the depth of the body. Anal base terminating below the origin of the last dorsal ray. Pectorals as long as head. Origin of ventrals in advance of the vertical of the fifth dorsal spine. Caudal rays forked but not so much branched as in true *G. insidiator.*

The coloration of the spirit specimen shows that the rosy patch on the gill-covers extends, in this subspecies, well into the excavated occipital region. The margin of the dark area on the soft dorsal fin is roundly convex. There are more whitish blotches on the dorsal and pectoral fins in this subspecies than in typical *G. insidiator* and there are two large white blotches on the back below the first dorsal fin.

Described from the holotype of the subspecies, a specimen 150 mm. in standard length or 7½ inches in total length, from Tasmania. Australian Museum registered number B.5786.

Family NOTOGRAPTIDÆ.

Genus **Notograptus** Günther, 1867.

Notograptus livingstonei sp. nov.

D.lxviii/2; A.xl/2; V.i.; P.19; C.9.

Length from snout to vent (49 mm.) 1·18 in distance between vent and hypural joint (58). Head (15) 2·2 in its distance from the vent (34). Depth at vent (7) 2·1 in head; orbit (2·5) 6·0 in same. Snout (2) 1·25 in orbit and greater than interorbital width (1·5) which is 1·7 in orbit. Pectoral (7·5) 2, caudal (10·5) 1·4, ventral (4) 3·7, posterior dorsal spine (5) 3, and posterior anal spine (4·5) 3·3 in head.

Body anguilliform, somewhat compressed anteriorly, markedly compressed posteriorly, and covered with minute, imbricate, oval scales which extend forwards to the nape and ventral fins, but leave the head, breast, and pectoral base naked. Snout rounded, head swollen posteriorly and flattened above and below. Some simple pores overlie canals around eye, along top of cheek, around preoperculum and chin, and across nape. Nostrils inconspicuous openings situated on a prominence. Mouth oblique, the maxillary extending well beyond eye. Lower jaw shorter than upper. A small barbel present. A broad band of granular teeth in each jaw, with a toothless space at each symphysis. Similar bands of teeth on palatines. Vomer toothless. A velum behind teeth of upper jaw. Tongue long, lanceolate. Eye large, with a superior lid. Opercular bones hidden beneath skin, unarmed; some fine radiating ridges on operculum. Gill-openings wide, lateral, separated by a narrow isthmus. Five branchiostegal rays, with broad membranes. Lateral line originating over operculum, passing obliquely over shoulder, and extending along top of each side to posterior portion of spinous dorsal fin.

Dorsal originating over operculum. Anterior spines short and soft; median and posterior spines longer and pungent, often with a more or less free pencil extending along the intermediate membranes. The two dorsal rays are branched but the second is also divided to its base and, like the last anal ray, joined to the caudal by membrane. Anal originating below the twenty-seventh dorsal spine. Anal spines all strong. Pectoral obtusely pointed, with a broad base. Ventrals each of one divided ray with a thick membrane; they originate in advance of the vertical of the first dorsal spine. Caudal lanceolate, its rays crowded.

General ground colour (in alcohol) brown, becoming lighter on fins, above and below head, and on ventral surface of thorax. Large brown ocelli with white margins extend in three to four rows along the body and tail. Similar but larger ocelli on the head becoming blackish on cheeks. Two to three rows of fuscous ocelli or spots, apparently without white margins, extend along the entire length of the dorsal fin and fade out on the caudal. Anal immaculate.

Described from the unique holotype of *Notograptus livingstonei*, a specimen 108 mm. long in standard length. Australian Museum registered number IA.4124.

Type-locality.—Between tide-marks at Broome, Western Australia; collected September, 1929, by Mr Arthur Alva Livingstone of the Australian Museum, after whom the species is named.

This new species is closely allied to *Notograptus guttatus* Günther[72] from Cape York, Queensland, but differs at sight in having fewer rows of ocelli on the body. When compared with the Queensland specimen of *N. guttatus* which has been so beautifully figured by McCulloch,[73] the type of *N. livingstonei* is observed to have an increased number of dorsal and anal spines. In *N. guttatus* the anterior dorsal membranes only are usually spotted, whereas in *N. livingstonei* the spots extend the whole length of the dorsal fin and also extend further back on the sides of the tail.

I have compared specimens of *N. guttatus* in the Australian Museum from the following localities with the new species, which is evidently a north-western Australian congener.

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[72] Günther.—Ann. Mag. Nat. Hist., (3) xx, July 1, 1867, p. 64.

[73] McCulloch.—Mem. Queensland Museum, vi, December 19, 1918, p. 94, pl. xxix.

Port Denison, Queensland (E. H. Rainford); 4 specimens, including the figured pleisotype. Palm Islands, Q. (Rainford). Black Island, Whitsunday Passage, Q. (Dr. Lockwood). Thursday Island, Torres Strait and Lindeman Island, Whitsunday Passage, Q.; dredged in 9 fathoms (Melbourne Ward).

References to literature on *Notograptus guttatus* and synonymy are given in McCulloch's account quoted above.

Family GOBIIDÆ.

Genus **Parvigobius** Whitley, 1930.

Parvigobius Whitley, Austr. Zool., vi, 2, Jan. 14, 1930, p. 122. Orthotype, *P. immeritus* Whitley.

Head as broad as deep, not compressed. Chin and mandibles without barbels. No prominent ridges or flaps on head. Large scales on nape and on opercles, none on cheeks. Bands of microscopic teeth in each jaw. Snout much shorter than diameter of eye.

Body covered with scales in less than thirty transverse series. Shoulder girdle without fleshy lobes. Length of entire fish less than an inch and a half.

Six spines in first dorsal. Second dorsal and anal free from caudal. Ventral fins not forming a short rounded cup-shaped disc and not adnate to belly. Upper pectoral rays neither free nor differentiated from the others. Caudal rounded or truncate.

Parvigobius immeritus Whitley.

Gobius flavescens De Vis, Proc. Linn. Soc. N. S. Wales, ix, 3, Nov. 29, 1884, p. 689. Moreton Bay, Queensland. Lectotype in Australian Museum. Name preoccupied by *Gobius flavescens* Bloch and Schneider, Syst. Ichth., 1801, p. 73. *Id.* McCulloch and Ogilby, Rec. Austr. Mus., xii, 10, July 14, 1919, pp. 204 and 224, pl. xxxvi, fig. 3 (type). *Id.* McCulloch, Austr. Mus. Mem., v, 3, 1929, p. 369.

Parvigobius immeritus Whitley, Austr. Zool., vi, 2, Jan. 14, 1930, p. 122. New name for *Gobius flavescens* De Vis, preocc. Moreton Bay, Q. Holotype in Austr. Mus.

D.vi/9; A.8; P.15; V.5; C.12. Sc. 23. L. tr. 7.

Depth of the body before the ventrals (5 mm.) 4·2 in length to hypural joint (21); head (6·5) 3·2 in same. Eye (2), longer than snout, 3·2 in head. The interocular width is less than half the diameter of the eye. Depth of caudal peduncle (3) 2·1 in head. Breadth before pectorals (3·5) 1·4 in depth.

Head as broad as deep, with a short snout. The cheeks are naked but there are a few large but weakly developed scales on the operculum. Some large pores around eyes, along nuchal grooves, and along edge of preoperculum. Several rows of microscopic papillæ on operculum. Eyes large, superolateral. Jaws subequal. Nostrils separate, situated on prominences as minute tubes. Maxilla reaching to below the anterior portion of the eye. A buccal velum in each jaw. Teeth microscopic, in bands. Gill-openings lateral. Branchiostegal membranes attached to a broad isthmus.

Body compressed, with a broad and rather long peduncle. Scales large and angular, ctenoid on the body, but apparently degenerating to cycloid on nape and opercula. Seven predorsal scales, the most anterior being behind the interocular space. Some degenerate scales on breast and pectoral bases. A genital papilla.

First dorsal originating over the anterior half of the pectorals; the second spine is longest and there is a broad membrane between the fifth and sixth spines. Anterior dorsal rays higher than dorsal spines. Anal origin a little behind the vertical of the origin of the second dorsal. Pectoral rounded, the middle rays longest, reaching to the eleventh transverse scale-row. Ventrals inserted behind the vertical of the pectoral base and about the same length as the pectoral fins. Caudal margin gently rounded.

Colour, in alcohol, light brown mottled with blackish. There is a blackish blotch on the posterior membranes of the spinous dorsal and about three series of dark spots on the soft dorsal. There are fuscous marks on each lip and crossing the cheeks from the eyes. An irregular series of dark blotches and dark-edged scales along the flanks, especially along the middle of each side. Two black blotches, one above the other, at the root of the caudal. A series of black spots along the ventral surface near the anal fin. Pectorals, ventrals, and anal light, with some fuscous punctulations. Caudal rays chequered with black.

Described from the larger of two specimens in the Australian Museum. Registered No. IA.3911. These were collected by Mr. Hugh James in the Coraki district, Richmond River, northern New South Wales. The species has not been known previously outside Queensland.

Family ALUTERIDÆ.

Genus **Navodon** Whitley, 1930.

Navodon Whitley, Austr. Zool., vi, 2, Jan. 14, 1930, p. 179. Orthotype, *Balistes australis* Donovan.

Gill-opening short, below eye. Dorsal spine originating over eye, with a row of barbs on each side; a small second dorsal spine. Dorsal and anal fins not angulate, with more than thirty rays. A small immovable ventral spine; ventral flap moderate. Body not elongate, its depth at origins of soft dorsal and anal fins less than half length to hypural or more than length of head. Body covered with small, close-set, spiny scales, some of which may tend to develop a flange, giving them a mushroom-like appearance. No cutaneous flaps on body or fins; no spines or bristles on caudal peduncle.

Navodon australis (Donovan).

Balistes australis Donovan, Naturalists' Repository, iii, May 1, 1824, pl. lxxvi and text. Van Diemen's Land. *Id.* Gray, Narr. Surv. Coasts Austr. (King), ii, 1826, appendix, p. 435.

Monacanthus rudis Richardson, Proc. Zool. Soc. Lond., viii, August, 1840, p. 27; Trans. Zool. Soc. Lond., iii, Jan. 23, 1844, p. 166. Port Arthur, Tasmania. Type in British Museum. *Id.* Richardson, Tasm. Journ. Nat. Sci., i, 1842, p. 105. *Id.* Richardson, Zool. Voy. Erebus and Terror, Fish., 1846, p. 65, pl. xl, figs. 7-8. *Id.* Hollard, Ann. Sci. Nat., Paris, Zool., (4) ii, 1854, p. 339 (Tasmanian specimen described). *Id.* Günther, Cat. Fish. Brit. Mus., viii, 1870, p. 244. *Id.* Saville-Kent, Nat. in Austr., 1897, p. 190, col. pl. vii, central fig. (S. Tasmania).

Cantherhines australis Whitley, Abstr. Proc. Linn. Soc. N. S. Wales, No. 429, Sept. 27, 1929; Proc. Linn. Soc. N. S. Wales, liv, 6, Feb. 15, 1930, p. 1.

In "The Naturalists' Repository," Donovan[74] gave an excellent description and figure of a Leatherjacket from Van Diemen's Land which has not been generally recognized since it was first named, and is omitted as such from lists of Tasmanian fishes. It has D.36; A.31 and two rows of barbs on dorsal spine. In the Australian Museum, I found an eight-inch specimen (No. B.5594) labelled "*Cantherines* sp. Tasmania." This agrees with *Balistes australis* and shows that Donovan's species is closely allied to *Monocanthus setosus* Waite,[75] from off Wollongong, New South Wales, which is obviously a deeper water relative with more superior gill-opening, larger eyes and more spinose integument. The two species may be segregated from the other Australian Leatherjackets by being placed in my genus *Navodon.*

Monacanthus rudis Richardson appears to be conspecific with *Balistes australis* Donovan. The fish identified as *Monacanthus rudis* by Castelnau,[76] having small teeth, and spines on the caudal peduncle, is not this species. Castelnau also suggested the identity of *Monacanthus freycineti* Hollard with *M. rudis* Richardson, but Hollard's figure[77] shows a very different fish from Mauritius with strong pelvic spine, and with spines on caudal peduncle.

Navodon setosus (Waite).

Monocanthus setosus Waite, Austr. Mus. Mem., iv, 1, Dec. 23, 1899, p. 91, pl. xvi. Off Wollongong, New South Wales; "Thetis" Expedition.

Cantherines setosus Waite and McCulloch, Trans. Roy. Soc. S. Austr., xxxix, 1915, p. 472, pl. xiv (topotype).

Besides the type, I have examined specimens in the Australian Museum trawled off the coast of New South Wales and in Bass Strait.

Family DIODONTIDÆ.

Genus **Allomycterus** McCulloch, 1921.

McCulloch[78] proposed the genus *Allomycterus* in the following terms:

Near *Dicotylichthys*, having a bifid nasal tentacle without openings, but all the spines are three-rooted and fixed. The greater part of the forehead is naked, and the dorsal and anal fins have each about sixteen rays. The bifid nasal tentacle and increased number of dorsal and anal rays distinguishes this genus from *Chilomycterus.*

Type.—*Diodon jaculiferus*, Cuvier.

The New South Wales fish upon which he based this genus was not, however, the true *Diodon jaculiferus* Cuvier.[79] The genotype of *Allomycterus* is thus *Diodon jaculiferus* McCulloch (*non* Cuvier), which requires a new name.

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[74] For bibliographical notes on Donovan's "Naturalists' Repository," see Raynell, Proc. Malacolog. Soc. London, xii, 1917, p. 309, and Sherborn's "Index Animalium."

[75] Waite.—Austr. Mus. Mem., iv, 1, Dec. 23, 1899, p. 91, pl. xvi.

[76] Castelnau.—Proc. Zool. Acclim. Soc. Vict., ii, 1873, p. 54.

[77] Hollard.—Ann. Sci. Nat., Paris, Zool., (4) ii, 1854, p. 336, pl. xii, fig. 3.

[78] McCulloch.—Rec. Austr. Mus., xiii, 4, April 12, 1921, p. 141, pl. xxiii, fig. 2. Off Botany Bay, New South Wales; trawled in 60 fathoms.

[79] Cuvier.—Mem. Mus. d'Hist. Nat., iv, 1818, p. 130, pl. vii, "la mer des Indes" (Péron). Type locality, Western Australia, by present designation.

Allomycterus pilatus sp. nov.

Allomycterus jaculiferus McCulloch, Rec. Austr. Mus., xiii, 4, April 12, 1921, p. 141, pl. xxiii, fig. 2. Off Botany Bay, N. S. Wales (60 fathoms). Not *Diodon jaculiferus* Cuvier, 1818. *Id.* McCulloch. Austr. Zool., ii, 3, 1922, p. 130; Check-List Fish. N. S. Wales, 1922, p. 104.

The holotype of *A. pilatus* is the specimen described and figured by McCulloch. Austr. Mus., registered number I.15159. New South Wales; trawled.

The southern Australian form may be a distinct species, but I have no specimens at hand for comparison. The New Zealand form is receiving the attention of my colleague, Mr. W. J. Phillipps.

The true *Diodon jaculiferus* was described by Cuvier from a specimen collected by François Péron. This naturalist obtained specimens in Tasmania, western and eastern Australia, and Timor, but his specimens were mixed, owing to shipwreck, and it is now very difficult to ascertain the type localities of many of the new species which had been collected by him and described by subsequent authors after his death. When Mr. A. A. Livingstone returned from Western Australia, he brought back a porcupine-fish dredged in five fathoms from between Broome and Cape Bossutt (Austr. Mus., registered number IA.4231), which agrees exactly with *Diodon jaculiferus* Cuvier and differs from McCulloch's New South Wales specimens sufficiently to show that it is neither conspecific nor congeneric with them. It is therefore evident that the type of Cuvier's species came from Western Australia and probably from the north-west portion of that State. The genus *Allomycterus* McCulloch must be applied to the New South Wales form, *A. pilatus*, because McCulloch gave a description of it before he named his wrongly identified genotype, but the typical Western Australian species requires a new generic name, which may now be proposed as follows.

Tragulichthys, gen. nov.

Orthotype, *Diodon jaculiferus* Cuvier, as identified by me.

Near *Allomycterus*, but with each nostril in the form of a raised flap, with a perforation anteriorly and posteriorly. All spines three-rooted and fixed, except two long ones behind each pectoral, which are movable. Spines on posterior half of sides much longer and stronger than those on anterior half. A spine beside each nostril and one in centre of forehead. Less than sixteen dorsal and anal rays. Tail slender.

The form of the nostrils distinguishes *Tragulichthys* from *Chilomycterus* as described by Brisout de Barneville.[80]

To summarize, the eastern and western forms may be separated by means of the following key.

Western Australian. D.12. A.12. P.21. Head more than one-third standard length. Caudal pointed, much longer than dorsal or anal. A spine beside each nostril and one on middle of forehead. Spines on body long. Snout shorter than eye. Nostril

[80] Brisout de Barneville.—Rev. Mag. Zool., ix, April, 1846, p. 140. *Ex* Bibron MS. Haplotype, *C. reticulatus* (Bibron) B. de B. (? = *Diodon reticulatus* Linn.). "Narines non closes au sommet, mais chacune ayant l'apparence de deux lèvres ou formée de deux tentacles réunies à la base."

closed at the summit, with two perforations. Posterior dorsal and anal rays long. Back not spotted. Three small lateral blotches .... *Tragulichthys jaculiferus* (Cuvier), pl. xv, figs. 2 and 3.

Eastern Australian. D.16. A.16. P.20. Head one-third of standard length. Caudal rounded, hardly longer than dorsal or anal. No spines beside nostrils or on middle of forehead. Spines on body short. Snout longer than eye. Nostril with an anterior and a posterior lobe, not closed at summit. Posterior dorsal and anal rays short. Back spotted. Large blotches on sides .... *Allomycterus pilatus* Whitley.

Family MOLIDÆ.

Genus **Mola** Cuvier, 1798.

Mola ramsayi (Giglioli).

(Plate xvi, figs. 1, 3 and 4; and Figure 2.)

? *Tetraodon mola* Linné, Syst. Nat., ed. 10, 1758, p. 334; ed. 12, 1766, p. 412, as *Tetrodon*. Mediterranean Sea.

Orthagoriscus sp. Aubin, Pap. Proc. Roy. Soc. Tasm., Aug., 1869, p. 28 (Spring Bay, Tasmania).

Orthagoriscus truncatus Hutton, Fishes New Zealand, 1872, p. 73 (Auckland, N.Z.). Not *Tetrodon truncatus* Retzius 1785.

Orthagoriscus mola Castelnau, Proc. Zool. Acclim. Soc. Vict., i, 1872, p. 211 and Res. Fish. Austr., 1875, p. 3 (Hobson's Bay, Victoria). *Id.* Hutton, Trans. N.Z. Inst., v, 1873, p. 271 (Auckland, N.Z.). *Id.* Macleay, Proc. Linn. Soc. N. S. Wales, i, 1875, p. 12 (Port Stephens, N.S.W.). *Id.* Johnston, Proc. Roy. Soc. Tasm., 1882 (1883), p. 137, and *ibid.* 1890 (1891), p. 38 (Tasmania). *Id.* Hamilton, Trans. N.Z. Inst., xviii, 1886, p. 135 (Napier, Hawkes Bay, N.Z.). *Id.* Williams, *ibid.* xxv, 1893, p. 110, pl. viii*a* (Poverty Bay, N.Z.). *Id.* Drew, *ibid.*, xxix, 1897, p. 286 (Napier, N.Z.). *Id.* Parker, *ibid.* xxix, 1897, p. 627 (Otago, N.Z.). *Id.* Fletcher, Proc. Linn. Soc. N. S. Wales, liv, 1929, pp. 225 and 227, *ex* Macleay MS. (Port Stephens and Port Jackson, N.S.W.) Probably not *Tetraodon mola* Linné.

Orthragoriscus ramsayi Giglioli, Nature, xxviii, Aug. 2, 1883, p. 315. "Southern Hemisphere" = Sydney, New South Wales. Type presented to British Museum. *Id.* Ramsay, Cat. Exh. N.S.W. Court, Internat. Fisher. Exh., London, 1883, p. 46; Fisheries of the Colony (Legis. Assembly, N.S.W.), 1884, append. B, p. 27.

"Sunfish" Waite, Austr. Mus. Mem., iv, 1899, p. 7 (Port Stephens, N.S.W.).

? *Mola mola* Fountain and Ward, Ramb. Austr. Nat., 1907, pp. 155 and 315 (King George's Sound and Queensland). Records unreliable, as are all the fish notes in this book.

Mola mola Waite, Rec. Canterb. Mus., i, 1, 1907, p. 34 (N.Z.). *Id.* Stead, Fish. Austr., 1906, p. 227, fig. 82; Abstr. Proc. Linn. Soc. N. S. Wales, Nov. 25 (27), 1908, and May 25 (27), 1910; and Proc. Linn. Soc. N. S. Wales, xxxiii, 1909, p. 797 (N.S.W.). *Id.* Waite, Trans. N. Zeal. Inst., xlv, 1913, p. 223, pl. ix (Christchurch, N.Z.). *Id.* Phillipps, Rept. Domin. Mus. in Rept. Dept. Intern. Affairs, N.Z., 1919, p. 6 (Picton, N.Z.). *Id.* Waite, Rec. S. Austr. Mus., ii, 1, 1921, p. 198, fig. 332; Fish. S. Austr., 1923, p. 230 (South Australia). *Id.* McCulloch, Austr. Zool., ii, 3, 1922, p. 130, fig. 374*a*. *Id.* Phillipps, N.Z. Journ. Sci. Tech., viii, 3, 1926, pp. 169-172, figs. 1-3 (New Zealand records reviewed). *Id.* Gudger, The Scientific Monthly, xxvi, 1928, pp. 257-261 and

figs. N. S. Wales record-sized specimens; quotes article on Australian specimen in Wide World Mag., 1910. *Id.* McCulloch, Austr. Mus. Mem., v, 3, 1929, p. 436. Probably not *Tetraodon mola* Linné.

The synonymy of *Mola mola* (Linné) is so extensive and the amount written about this species so large that I have made no attempt to tabulate all the references here, especially as much of the literature is not available to me. It seems, however, that the Australian and New Zealand species is worthy of nominal distinction so I am reviving Giglioli's name for it, as he appears to have been the first to apply a new name to this form. A list of some of the synonyms of *Mola mola* has been given by Günther[81] and extended by Jordan and Snyder.[82] The references listed above indicate the more important Australasian records. Schmidt[83] has recently recorded some observations on *Mola*, and Damant[84] has discussed its method of locomotion. There is also a varied literature on the anatomy of this peculiar genus.

Description of a Botany Bay Specimen.

Upper profile of head oblique, gibbous; lower profile much less oblique with a deep rounded chin. Two large supraorbital bosses, one over each eye, join anteriorly to form a nose-like protuberance on the snout. A larger but less pronounced gibbosity extends along each cheek to below pectoral fins. Jaws beak-like, entire, without median suture. Lips blackish. Eye nearer snout than pectoral, situated in the broad groove between the bosses over the eye and on the cheek. Eye large, fatty, entirely free at its edges. Pupil dark milky-blue with a silvery ring. Rest of eye white, with a smoky tinge. A broad velum in lower jaw, behind which is the broad, thick, rounded tongue. A deep sulcus before the two small nostrils, which have circular, black lips. Gill-flap rounded, placed somewhat obliquely, subequal in width to the diameter of the eye. A broad flange inside gill-opening. Ventral outline subhorizontal.

Body elongate-elliptical, compressed, and covered, like the head, with a hard integument formed of close-set polygonal scutes. Each scute has a rugose central spine and is silver in colour on the sides. There are about ten scutes to an inch on the cheek.

Quantities of greyish, jelly-like mucus apparently covered the living animal but left the dêad specimen a bone-white colour with a faint pink tinge on head and fins.

Dorsal originating slightly in advance of anal and in posterior half of fish. The fin is high, pointed, with a flabby tip, convex posterior margin, and a thick muscular base. Fin-rays indistinguishable through the thick integument but close-set and formed of brittle bone near tip of fin. Anal fin similar and subequal to dorsal. Tail roughly semicircular, with the margin scalloped into about twelve lobes. Pectoral immediately behind gill-opening, thick, broadly rounded, and with a long, muscular base. The pectorals do not reach the vertical of the dorsal

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81 Günther.—Cat. Fish. Brit. Mus., viii, 1870, pp. 317-319.

82 Jordan and Snyder.—Proc. U.S Nat. Mus., xxiv, 1901, pp. 260-261 A later list is given by Jordan, Evermann and Clark, Rept. U.S. Comm Fish., 1928, pt. ii, 1930, p. 503.

83 Schmidt.—Medd. Havunders., Kjobenhavn, Ser. Fiske, vi, 6, 1921, pp. 1-13, pl. i and text-figs.; and Nature, March 17, 1921, pp. 76-79, figs. 1-6.

84 Damant.—Nature, cxvi, 1925, p. 543, figs.

and anal fins. Anus a small opening a little before anal fin. Below the scutes which cover the body the flesh is firm and white and from about 2½ to 4 inches thick on sides and abdomen.

Intestine over twenty-four feet long and of fairly uniform calibre and surrounded by vascular mesenteries. The intestinal walls are thick and enclose a narrow lumen. Liver very large and of a deep treacle yellow colour and, in the specimen examined, infested throughout with white worms. A search for parasites in the alimentary canal was unproductive.

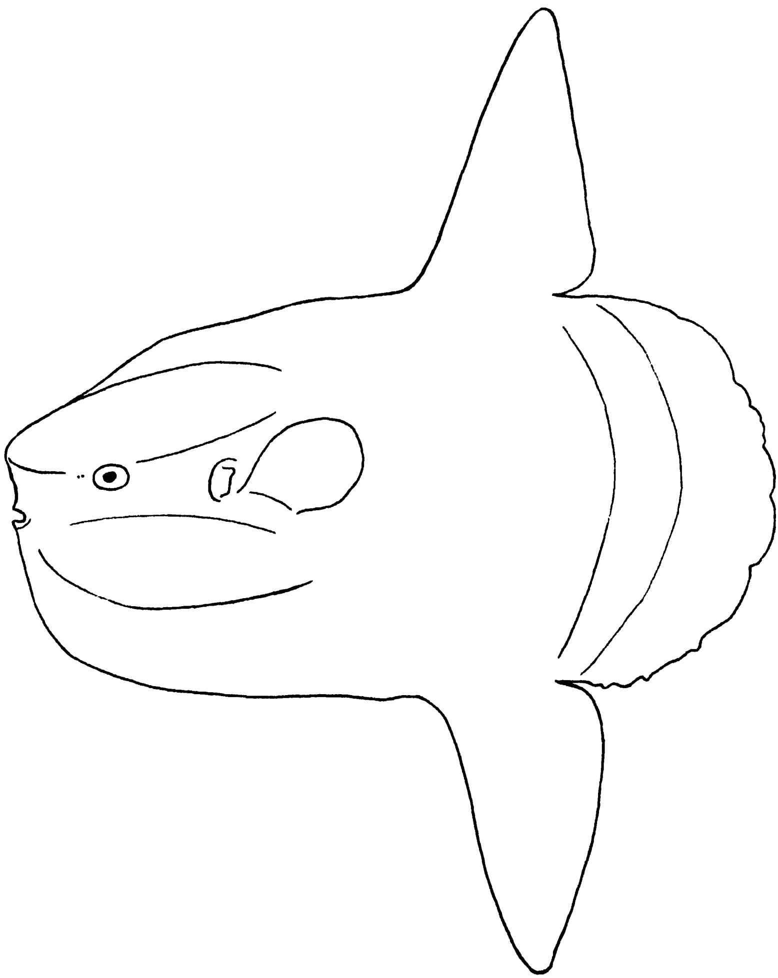


FIGURE 2.
Mola ramsayi (Giglioli).
A small specimen from Yarra Bay, Botany Bay, New South Wales.
Also represented on Plate xvi, figure 1.
(Gilbert P. Whitley, del.)

Described from a not fully grown sunfish, apparently male, seven feet four inches in total length and in a fresh state at Yarra Bay, Botany Bay, New South Wales: November, 1929. Specimen not preserved, but the photograph reproduced here was made on the spot by Mr. G. C. Clutton and the accompanying diagram drawn to scale by myself from sketches and measurements which I made on the same occasion.

This specimen had been caught by some fishermen about a week previously, when it had been swimming upright in the bay with the dorsal fin out of water like a shark. The men had tried to shoot it but the bullets made no mark on the hard integument.

I observed the specimen a few days before it died. The dorsal and anal fins were both moved to one side simultaneously, and then to the other; the anterior margins of the fins had a screwing or twisting motion comparable to that of the pectoral fin of many fishes. The pectorals of the sunfish were continually flapping and the flange in the gill-opening moved up and down. As seen in the water, the general colour in life was olive-greyish, browner above, but this may have been caused by external growths or mucus. The lips and inside of mouth were pinkish and the teeth dirty white.

The fishermen stated that usually water is taken in at the mouth and ejected through the gill-slits but that the fish can squirt a large jet of water from the mouth when it is at the surface. They also mentioned that sunfish may be met with lying flat on the ocean surface as if basking in the sun.

Dimensions of Botany Bay Specimen.

	Feet.	Inches
Total length	7	4
Tip of dorsal to tip of anal	8	8
Head from tip of snout to gill-opening	1	10
Girth around head	7	8
Anterior margin of eye to snout	1	0⅛
Longitudinal diameter of eye		4¼
Vertical diameter of eye		3¼
Width of gill-opening		4⅛
Width of mouth		6
Gape of mouth		4½
Eye to posterior nostril		2½
Between nostrils		0¼
Interorbital	1	5½
Depth of body from base of dorsal to that of anal	4	0
Termination of dorsal to that of anal	3	9
Breadth at cheeks	2	2
Breadth at centre of body	1	8
Top of supraorbital boss to ventral profile behind eye	2	6
Anterior margin of eye to origin of pectoral	1	6
Anterior margin of eye to origin of dorsal	3	6
Anterior margin of eye to origin of anal	4	2
Dorsal base	1	11
Dorsal height	2	9
Anal base	1	9
Anal height	2	8
Pectoral base		8
Pectoral length	1	1
Width of dorsal at half its height	1	6
Width of anal at half its height	1	6
Anterior insertion of pectoral to origin of dorsal	2	7

Dimensions of Botany Bay Specimen—Continued.

	Feet.	Inches.
Anterior insertion of pectoral to origin of anal	3	0
Anterior insertion of pectoral to end of tail	5	3
Origin of dorsal to tip of snout	4	0
Snout to symphysis of lower jaw		8
Symphysis of lower jaw to rounded angle of chin	1	6
Chin to origin of anal	3	8
Termination of dorsal to that of anal, around tail	5	8

Another specimen was caught at Frenchman's Bay, La Perouse, only a few hundred yards from where the specimen described above had been obtained about a year previously. The La Perouse specimen was larger, being 8 ft. 10 in. long and 11 ft. 2 in. high, but otherwise agreed in general features with the Yarra Bay example. It was caught by Mr. H. Moore of Botany at 6.30 p.m. on 6th December, 1930, and examined by me two days later. General colour steel-greyish, white below. Margin of tail irregular, with more than twelve lobes. The nose-like protuberance on the snout was damaged so some of the head measurements were not taken, but the following may be noted for comparative purposes.

	Feet.	Inches.
Total length	8	10
Tip of dorsal to tip of anal	11	2
Head from tip of snout to gill-opening	2	1
Longitudinal diameter of eye		4¼
Vertical diameter of eye		4
Width of gill-opening		6½
Width of mouth		7
Gape of mouth		4
Eye to posterior nostril		3¾
Between nostrils		0¼
Depth of body from base of dorsal to that of anal	4	8
Termination of dorsal to that of anal	4	3
Top of supraorbital boss to ventral profile behind eye ..	4	1
Anterior margin of eye to origin of pectoral	1	8½
Anterior margin of eye to origin of dorsal	4	4
Anterior margin of eye to origin of anal	6	0
Dorsal base	2	2
Dorsal height	3	7
Anal base	2	1
Anal height	3	3
Pectoral base		9
Pectoral length	1	2
Width of dorsal at half its height	1	8¼
Width of anal at half its height	1	9¼
Anterior insertion of pectoral to origin of dorsal	3	5
Anterior insertion of pectoral to origin of anal	4	6
Anterior insertion of pectoral to end of tail	6	2

The La Perouse specimen was parasitized by stalked barnacles on the roof of the mouth and copepods on the slimy integument of the body, but chiefly on the side of the head between the eye and gill-opening. The specimen was not dissected. Six "pilot fish" were reported to have been swimming around the fish when first caught, but only one was preserved, and was found to be the young of the New South Wales form of the rare *Centrolophus maoricus* Ogilby.

A large sunfish was caught at Bondi, near Sydney, on 26th September, 1928, but I was in Queensland at the time and thus did not see the specimen, which was not preserved.

Early New South Wales Records.

In an exercise book containing notes on fishes written by the late Dr. E. P. Ramsay, of the Australian Museum, in the eighties of last century, several captures of sunfishes in New South Wales are recorded. The first sunfish to be noticed from this State was that from which Mr. John Brazier obtained so many parasites at Port Stephens on 28th November, 1874 (Macleay, 1875). It seems noteworthy that *Mola ramsayi* is usually caught inshore or stranded in New South Wales at the end of the year and the species seems restricted in distribution to New Zealand and the south-eastern quadrant of Australia. The following notes are taken from Ramsay's MSS., with my annotations in square brackets.

Orthagoriscus sp. Taken Nov., 1882, at Manly, Port Jackson. Bought of J. Skinner for the sum of £5 [Austr. Mus. No. I.2742]. Total length with tail, 5 ft. 8·5 in. From the vent to the base of the dorsal fin across the body, 3 ft. 7 in. From the tip of the dorsal to the tip of the anal fin, 8 ft. 6·5 in. Length of the dorsal fin, 2 ft. 9 in. Width of dorsal at base, 1 ft 6 in. Length of anal fin, 2 ft. 7·65 in. Width of anal at base, 1 ft. 1 in. The pectoral fin is 11 in. by 8 in width. From the snout to the gill-opening, 1 ft. 6 in. From the snout to the eye, 8 in. Gill opening, 4⅜ in × 2⅛ in. Eye opening 3 in. × 2⅜ in. From snout to a line between the dorsal and anal fins, 3 ft. 5 in. Greatest thickness through the body, a little behind and above pectoral, 1 ft

This fish, weighing about 5 cwt., was taken at Manly Beach, another caught about the same time or a day or two sooner was taken at Botany in the seine

These fish appear to travel about in pairs or couples. In every instance that they have been seen or taken on our coast this has been the case.

Orthagoriscus sp. [Evidently the holotype of *O ramsayi* Giglioli]

A very large specimen was found aground near Chadwick's Mills in Darling Harbour It was seen first among the shipping and for some unknown reason forced itself up between the vessels and the shallows into black mud. Boats prevented its escape and finally a chain was passed under it and it was hauled bodily up *alive* by a crane on to the timber skids of the wharf and placed on a truck. Here some fools began to hack it about the head and pectoral fin with an axe and greatly mutilated it. The foreman's (Mr. Connelly's) attention was drawn to the fact and he was good enough to order it to be sent to the Museum.

This fish measured 8 feet in length and eleven feet from tip to tip of the fins. The body near the pectoral fins and on other parts was covered with Whale Lice. Intestinal worms were numerous but small The flesh just under the skin was eaten away in irregular patches and the cavities filled with a greasy core resembling soft ambergris in substance, but *without* any *smell*; these irregular holes were 2-3 inches across and 1-2 deep, about twenty in a space of 3 ft. square In one hole was found a species of tape worm.

This specimen had in its youth received an injury in having the end of the anal fin bitten off. It weighed 1 ton 3 cwt.

This specimen was ultimately handed over from the Fisheries Exhibition, London, 1883, to the British Museum.

Orthagoriscus sp. Dec. 16th, 1883. A large specimen taken by some fishermen at Manly and sold for £7 10s to the Museum. [Austr. Mus. No. I.9412.]

This specimen weighed 1 ton 6 cwt. We had great difficulty in bringing it home, having to tow it from Manly, a distance of about five miles or more; across the Heads where there was a sea on we nearly lost it.

Length, 8 ft. 4 in. Width across the fins from tip to tip, 12 ft. Length of dorsal fin, 3 ft. 6 in. Width of the dorsal fin, 2 ft. 6 in. Tail four feet between the paired fins [around tail]; width at central portion [*i.e.*, from base of dorsal to that of anal], 2 ft. From the mouth to opposite the base of the anal fin, 5 ft. 2 in. Anal fin, 3 ft. 6 in. by 2 ft. 5 in. wide. Length of the body in front of the dorsal and anal fins, 5 ft. From snout to eye, 14 in. The eye, 3·5 in. × 3·65 in. From snout to gill-opening, 2 ft. 2 in.

The gill-opening, 5·5 in. × 5 in. Pectoral fin, 14 in. × 12·5 in. The greatest thickness is through the hump, behind the eye near the pectoral fin, where it is 2 ft. 3 in. through.

This specimen is mounted and slung in the Central Hall, first floor of the New Wing.

We have had taken on the N.S.W. coast in all [seven] specimens of the Southern Sunfish, which by Dr. Steindachner and Professor Giglioli are considered to be of a different species from the Atlantic *O. mola.*

The first record I have knowledge of concerning any specimen being taken on the N.S.W. coast is the very large one destroyed by Krefft.[85] This was taken by Skinner at Manly, near Sydney Heads, Port Jackson, and presented by Dr. J. C. Cox to the Museum under certain conditions. This for sake of reference we may call A.

A. Large specimen, Manly, caught 1871, Dec. 4th. [= November.] The next is B.

B. Large specimen measuring 15 feet between the tips of the fins caught at Broken Bay, 1874, and now in the Macleay Museum.

C. Small one captured at Broken Bay by Mr. A. Black. Presented by Dr. J. C Cox. Stuffed. Taken about the same time, 1874. Aust. Mus. [? No. I.5312, now without precise data.]

D. Medium sized one bought of Skinner at Manly. Nov., 1882. Stuffed in Aust. Mus. [No. I.2742.]

E. One about the same size taken in Botany Bay two days before.

F. Large specimen grounded near Chadwick's Saw Mills, Pyrmont, Darling Harbour, Dec., 1882. Exchanged with British Museum from Fisheries Exhib., London, 1883. Weight, 1 ton 3 cwt. [Holotype of *Mola ramsayi* (Giglioli).]

G. Another large specimen about the same size but weighing 1 ton 6 cwt. taken on 16th Dec., 1882, by some fishermen near Little Manly. [Aust. Mus. No. I.9412.]

The specimens in the Museum are C, D and G. From A to G appear to be all of one and the same species which have been named by Giglioli *O. ramsayi* but having compared these with a true *O. mola* which I got at Mevagissey [Cornwall, England; coll. A. Dunn, 1883, weight about 3 cwt.], I believe that they are only a southern form of the same species, nevertheless there are several very notable differences, in the scutes on the margin of the tail, nose, and chin, also in the form of the ossicles in the skin.

Orthagoriscus sp. [Note added later.] On Saturday, informed Mr. J. Brazier of a sunfish captured by some of the men of a steam tug just outside Port Jackson Heads. This fish makes the eighth specimen actually taken in (*sic*) Port Jackson. Total length, 7 ft. 10 in. Snout to gill-opening, 21·5 in. Eye to gill-opening, 9·5 in. From tip to tip of dorsal and anal fins, 9·5 ft. From base of fins, 3 ft. 4 in. Tail, 21 in. by 3 ft. 4 in. between the dorsal and anal fins [around tail]. Thickest part, through the tail, 10 in. Length of anal fin, 36 in. From anus to anal fin, 9½ in. Length of dorsal fin, 40½ in. Between the origin of dorsal and anal fins across the body, over 4 feet. From a perpendicular from the snout to the anus, 4½ ft. From chest, through the gill-opening, across the pectoral fin, to top of hump, 4 ft. 6in. Pectoral fin, 13 in. long × 10·9 in. at the base. Eye, 4·5 in. From snout to the eye, 8·5 in.

The remainder of Dr. Ramsay's notes are incomplete, but the details given above should serve as a basis for establishing whether *Mola ramsayi* is a valid species or not. In view of its large size, apparently different integument, and restricted distribution, I am of the opinion that it is.

[85] A sunfish was caught at Manly by J. Skinner in November, 1871. Dr. J. C. Cox sent it to the Australian Museum to have it mounted so that it could be shown about the country for a few months and then returned to the Museum, but it had begun to decompose when first brought in and a newspaper controversy took place in Sydney about the nuisance.—G.P.W., *ex* Krefft's MSS., A.261, p. 216, in Mitchell Library, Sydney.

EXPLANATIONS OF PLATES.

PLATE XI.

Tæniura lymnia halgani (Lesson). Dorsal and ventral views of a newborn specimen from Murray Island, Queensland.

PLATE XII.

Fig. 1.—*Pantolabus parasitus* (Garman). A specimen from Port Curtis, Queensland.
Fig. 2.—*Loligorhamphus normani* Whitley. Holotype from Townsville, Queensland.
Fig. 3.—*Loligorhamphus normani* Whitley. Dorsal view of head of holotype.

PLATE XIII.

Fig. 1.—*Neoplatycephalus castelnaui* (Macleay). A specimen from Albany, Western Australia.

Fig. 2.—*Microcanthus howensis* Whitley. Holotype from Lord Howe Island.

Fig. 3.—*Microcanthus vittatus* (Castelnau). A specimen from Western Australia.

Fig. 4.—*Microcanthus joyceæ* Whitley. Holotype from Shell Harbour, New South Wales.

Fig. 5.—*Microcanthus joyceæ* Whitley. Dorsal view of head of holotype (reduced).

PLATE XIV.

Glyptauchen insidiator Whitley. Holotype from Kurnell, Botany Bay, New South Wales.

PLATE XV.

Fig. 1.—*Phyllopteryx lucasi* Whitley. Holotype from Middleton Beach, Albany, Western Australia.

Fig. 2.—*Tragulichthys jaculiferus* (Cuvier). A specimen dredged between Broome and Cape Bossutt, Western Australia.

Fig 3.—*Tragulichthys jaculiferus* (Cuvier). Dorsal view of specimen shown in Figure 2.

PLATE XVI.

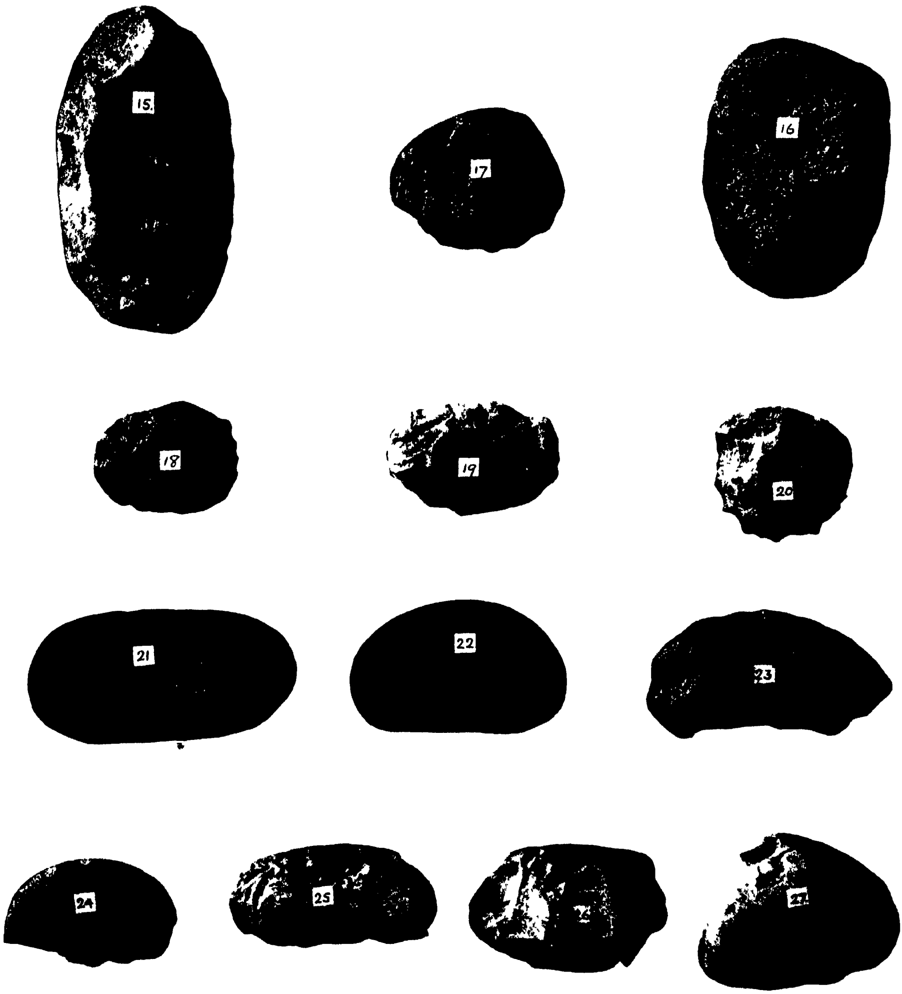
Fig. 1.—*Mola ramsayi* (Giglioli). A small specimen from Yarra Bay, Botany Bay, New South Wales Also represented in Figure 2, page 128.

Fig. 2.—*Aptychotrema rostrata* (Shaw and Nodder). Female and embryos from Trial Bay, New South Wales.

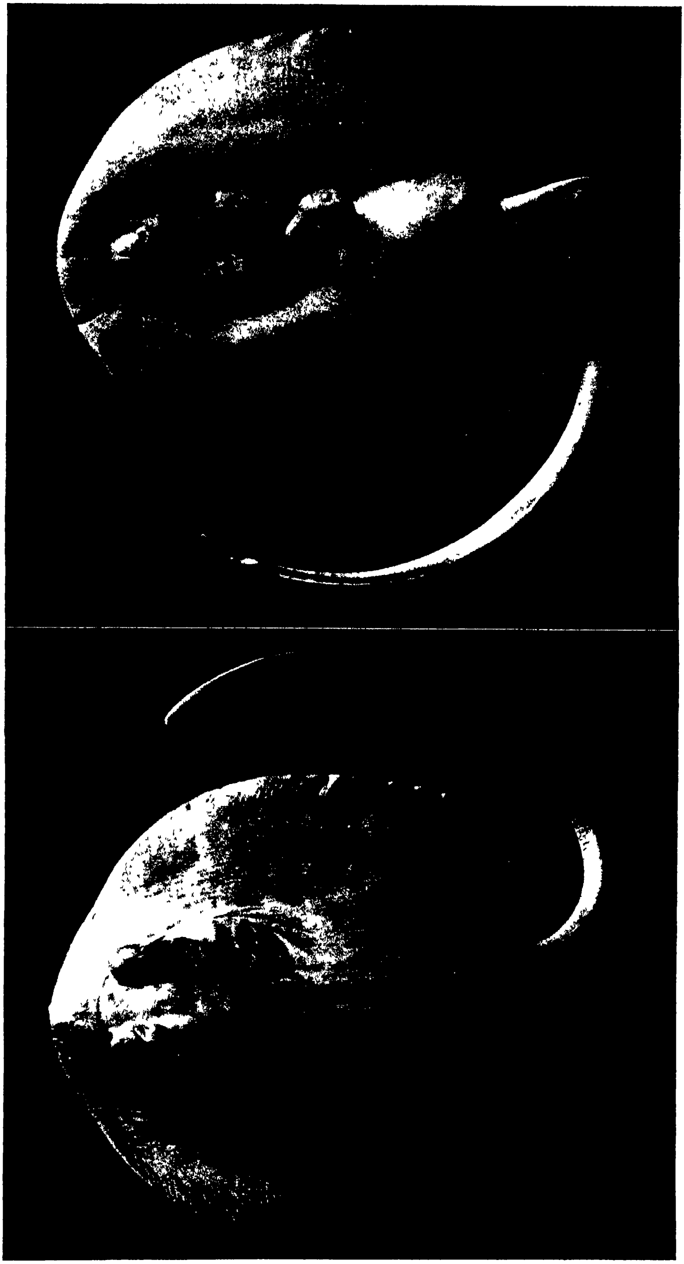
Fig. 3.—*Mola ramsayi* (Giglioli). A large specimen from La Perouse, Botany Bay, New South Wales.

Fig 4.—*Mola ramsayi* (Giglioli). Portion of the integument of the specimen shown in Figure 3.

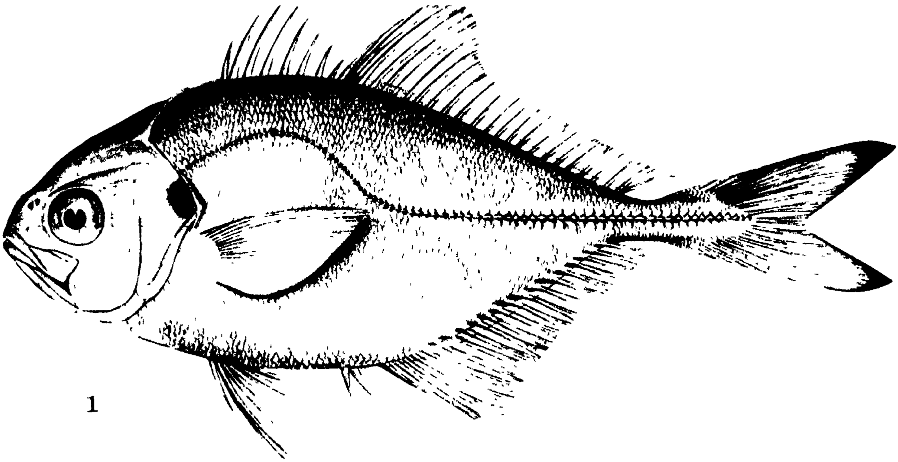
G. C. CLUTTON, photo.



G. C. CLUTTON, photo.



G. C. CLUTTON, photo.



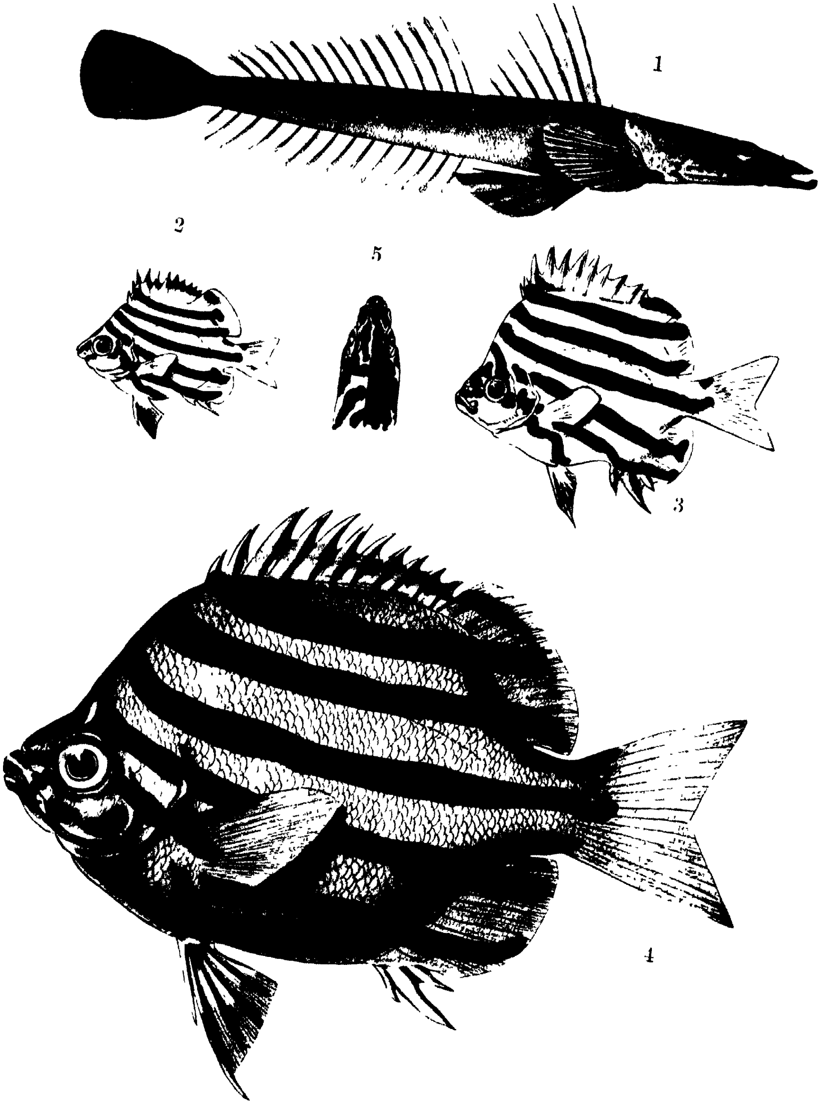
1

2

3

ETHEL A. KING (1) and JOYCE K. ALLAN (2 and 3), del.

PLATE XIII.



PHYLLIS F. CLARKE (1) and JOYCE K. ALLAN (2, 3, 4 and 5), del.

ETHEL A. KING, del.

1

2

3

G. C. CLUTTON, photo.

1

2

3

4

G. C. CLUTTON (1, 3 and 4) and A. MUSGRAVE (2), photo.

ON A NEW ASTEROID FROM QUEENSLAND.

By

Arthur A. Livingstone,

Assistant Zoologist, The Australian Museum.

(Plates xvii-xix.)

Goniodiscaster integer sp. nov.

(Pl. xvii, figs. 1–2.)

Description.—R. = 71 mm.; r. = 26·5 mm.; br. (at base of ray between third and fourth superomarginals and including the projecting inferomarginals) 21·5 mm. R. = 2·6 r. and 3·3 br. Rays equal in length, except in one case where the measurement falls short by 2 mm.

Disc moderately and evenly elevated. The rays taper gradually and evenly towards their free extremity. Interbrachial arcs moderately rounded. The papular areas, which are not noticeably distinct, are confined to the abactinal surface. The papular pores number from three to nine to an area. The areas are more distinct, and the pores in them more numerous, in the distal two-thirds of the ray. The pores are less distinct on the disc and not so numerous as on the rays. The papular areas extend along the ray to the second or third last superomarginal plate.

The plates of the abactinal surface are evenly and systematically arranged. A pentagon of one to six spine-like granules with bare conical tips occurs on the centre of the disc. The plates within the area formed by the pentagon are indistinct. The median radial or carinal series of plates commences in each case at one of the five granules or groups of granules forming the pentagon, and extends down the ray in a distinctive manner to end near the tip of the ray at or between the third and fourth last superomarginal plates. The median radial plates number twenty-two to a series; twenty-three in one case. They are fairly large in size on the disc but gradually become smaller as they continue along the ray. The series of plates lying next to the median radials are noticeably smaller, except near the tips of the rays, where all the plates are more or less of equal size. This second series ends, in the majority of cases, at the fifth last superomarginal. A third radial series containing three or four plates ends at the third superomarginal. One or two plates occur between the third series of radial plates and the plates bordering the interradial furrow. The plates bordering the interradial furrow are arranged in four pairs, the upper pair being always the largest, and also the largest on the abactinal surface. The lowermost pair are about the same in size as the radial plates lying next to them. The interradial furrow is conspicuous. The madreporite is oval in shape; it is situated in the interradial furrow between two of the groups of granules forming the pentagon, and measures 5·5 mm. across its widest part.

The granulation of the abactinal surface is coarse and uneven. The area within the pentagon, in addition to being heavily clothed in rounded granules, contains several conspicuous and blunt tubercles. Other plates of the abactinal surface are also clothed in granules of varying sizes, the big ones, almost approaching tubercles in size, being very common and prominent. The granules in the papular areas are small and of even size. The superomarginal plates increase very slightly in size as they proceed towards the tip of the ray. None are definitely swollen or enlarged near the tip. The superomarginals, which

number fifteen, are finely, evenly, and smoothly granulated except for the last five or six, which always bear a few noticeably larger granules. The inferomarginals correspond to the superomarginals. They project slightly beyond the superomarginals, prominently so in the interbrachial arc. The inferomarginals are granulated in a similar manner to the superomarginals and possess here and there minute pedicellariæ which have the appearance of split granules. The last seven or eight inferomarginals, particularly the last three, bear very large and prominent granules. These granules, in some cases, may be termed tubercles, on account of their comparatively large size and pointed extremities.

The plates of the actinal surface, with the exception of those near the margin, are very clearly defined and clothed in larger granules. Many plates bear, in addition to the granules, small pedicellariæ which agree in character with those found on the inferomarginals.

The adambulacral armature bears three distinct series of spines. The spines of the furrow series number six to a plate, the outermost one on either side being very short and small. These furrow spines are very slender and round. Behind the furrow series there are two or three large blade-like spines which are about twice as wide as long and webbed for a small portion of their length. Behind this second series there is a third series of spines, numbering two or three to a plate and having the appearance of granules rather than spines. Behind these again there occur spine-like granules of indifferent sizes, which are oddly placed and comparatively small. Situated on the inner side of each adambulacral plate, usually between the furrow comb and the series of spines placed immediately behind it, is a long forcep pedicellaria which has the appearance of an elongated spine split longitudinally.

Colour in life.—The collectors have explained that the colour in life varies, but notes were taken of the colour of one specimen, the holotype. They are: abactinal surface sage green; granules of pentagon dark green; margins slate colour. Actinal surface of disc brown; actinal surface of rays creamy white.

Growth variation.—Specimens with greater R. measurement than the holotype have the extreme tips of the rays considerably compressed laterally. The papular areas, particularly on rays, are more conspicuous and more deeply seated. The pentagon of tubercles on the disc may be entirely absent. The abactinal plates are not so clearly defined, but their central granules are enlarged to such an extent that the plates appear to be very distinctly swollen.

Material examined.—Five specimens. R. = 99 mm.; r. = 37 mm. R. = 86 mm.; r. = 34 mm. R. = 71 mm.; r. = 26·5 mm. R. = 64 mm.; r. = 27 mm. R. = 55 mm.; r. = 23·5 mm. The specimen with R. = 71 mm. has been selected as the holotype. All the specimens are housed in the Australian Museum, Sydney.

Remarks and Affinities.—It is not without hesitation that a new name has been considered necessary to accommodate the series of five specimens before me. The close relationship to *G. pleyadella* is obvious and it was first considered likely that the five specimens were but variations of that species. The smallest specimen approaches very closely to *pleyadella* in the shape of one ray (see plate) but the remaining rays are normal and characteristic of the other four specimens. In order to make an attempt to settle the question definitely, a loan of one of Bell's original specimens of *P. validus*, which was sunk as a synonym of *pleyadella* by Dr. H. L. Clark in 1909, was granted me by the authorities of the Museum of Comparative Zoology, Harvard, Cambridge, Mass., U.S.A. (see Pl. xix, figs. 3–4).

Even the acquisition of this specimen did not entirely clear up the doubt first experienced but it has at least been the means of furnishing the following table, which, it seems, separates the two forms sufficiently to venture a specific separation. Döderlein's (1896) largest specimen of *pleyadella* from Thursday Island is the same as the specimen of the species loaned to me from America (Bell's *validus*) and this certainly points to the conclusion that the true *pleyadella*, when in the adult condition, is constant, thus making the table below more reliable.

Characters of *G. pleyadella*.	Characters of *G. integer* sp. nov.
Rays comparatively short and stumpy; not noticeably tapering. Papular areas markedly sunken. Granulation of abactinal surface comparatively fine and even.	Rays longer in comparison and noticeably tapering. Papular areas on a specimen about the same size as one of *pleyadella* not markedly sunken. Granulation of abactinal surface coarse and uneven. Abactinal plates bear granules much larger than those between the papular pores.

It seems necessary to point out that there are in the collections of the Australian Museum two juvenile specimens (R. = 18 mm. R. = 20 mm.) of the genus *Goniodiscaster* from Whitsunday Passage, Queensland, which are identical with Döderlein's figures of juvenile *pleyadella* from Thursday Island (see Pl. xviii, figs. 1–2). The occurrence of young *pleyadella*, assuming that Döderlein's juveniles and the two before me are correctly determined, in a locality so close to Port Curtis, where the type of *integer* was collected, makes the question of the characteristics of young *integer* very interesting.

Localities.—Dredged in Port Curtis, Queensland, 12 fathoms; December, 1929; collected Messrs. W. Boardman and M. Ward (three largest specimens). Near Peel Island, Moreton Bay, Queensland (two smallest specimens).

EXPLANATIONS OF PLATES.

Plate XVII.

Fig. 1.—*Goniodiscaster integer* sp. nov. Abactinal surface of holotype (Austr. Mus. Catal. No. J: 5499). Slightly under natural size.

Fig. 2.—*Goniodiscaster integer* sp. nov. Actinal surface of holotype. Slightly under natural size.

Plate XVIII.

Fig. 1.—*Goniodiscaster pleyadella* (Lamk.). Abactinal surface of juvenile specimen from Whitsunday Passage, Queensland (Austr. Mus. Catal. No. J: 5315 part). R. = 20 mm. Slightly over 1·5 natural size.

Fig. 2.—Actinal surface of same specimen. Slightly over 1·5 natural size.

Fig. 3.—*Goniodiscaster integer* sp. nov. Abactinal surface of the largest specimen, a paratype (Austr. Mus. Catal. No. J: 5500). Slightly over 1·5 natural size.

Fig. 4.—*Goniodiscaster integer* sp. nov. Abactinal surface of one of two specimens from near Peel Island, Moreton Bay, Queensland (Austr. Mus. Catal. No. G: 11502). Natural size.

Plate XIX.

Fig. 1.—*Goniodiscaster integer* sp. nov. Portion of adambulacral armature of holotype. × 4·5.

Fig. 2.—*Goniodiscaster integer* sp. nov. Portion of abactinal surface of ray showing granulation and papular areas. Holotype. × 4.

Fig. 3.—*Goniodiscaster pleyadella* (= *Pentagonaster validus* Bell—co-type). Abactinal surface of specimen loaned by the Museum of Comparative Zoology at Harvard, Cambridge, Mass., U.S. America. Approx. natural size.

Fig. 4.—Actinal surface of same specimen. Approx. nat. size.

STUDIES IN ICHTHYOLOGY.

No. 5.*

By

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Ichthyologist, The Australian Museum, Sydney.

(Plates xx-xxi and Figures 1-2.)

Family HEPTRANCHIIDÆ.

Genus **Notorynchus** Ayres, 1855.

Notorynchus Ayres, Proc. Calif. Acad. Sci., i, 1855, p. 73. Type, *N. maculatus* Ayres = *N. platycephalus* Tenore (*fide* Garman, Bull. Mus. Comp. Zool. Harv., xxxvi, 1913, pp. 18–20).

Notorhynchus Jordan and Fowler, Proc. U.S. Nat. Mus., xxvi, 1903, p. 594.

The original definition of this genus is not available to me. The generic name is spelt *Notorhynchus* by Marschall and by Jordan, and *Notorynchus* by Scudder and by Garman.

Notorynchus macdonaldi, sp. nov.

(Plate xx, figs. 3–5.)

[Seven-gilled shark] Quoy, Voy. Astrolabe, Hist. Voy., i, 1830, p. 211 (Jervis Bay, New South Wales).

Heptranchus indicus Macdonald and Barron, Proc. Zool. Soc. Lond., Sept. 15, 1868, p. 371, pl. xxxiii [off Flinders Id.], Bass Strait (F. M. Rayner, Jan., 1858). Not *Notidanus indicus* Agassiz, 1835 = *Squalus platycephalus* Tenore, 1810 (*fide* Garman, 1913, and Sherborn, Index Anim.).

Notidanus indicus Hutton, Cat. Fish. New Zealand, 1872, p. 79, and Trans. N.Z. Inst., v, 1873, p. 271. *Id.* Ramsay, Proc. Linn. Soc. N. S. Wales, v, 1880, p. 96 (Port Jackson, N.S.W.; 6 ft. 4 in.). *Id.* Johnston, Proc. Roy. Soc. Tasm., 1882 (1883), p. 138, and *ibid.* 1890 (1891), p. 38 (Tasmania). *Id.* Ogilby, Cat. Fish. N. S. Wales, 1886, p. 3 (Jervis Bay and Sydney, N.S.W.). *Id.* Parker, Nature, xliii, Dec. 11, 1890, p. 142, fig. (of sternum). Not *N. indicus* Agassiz, 1835.

Heptanchus indicus Castelnau, Proc. Zool. Acclim. Soc. Vict., i, 1872, p. 217 (Hobson's Bay, Victoria). *Id.* Haswell, Proc. Linn. Soc. N. S. Wales, ix, 1884, pp. 88 and 381, pl. i, fig. 5, and pl. x, figs. 1–2. *Id.* Ogilby, Proc. Linn. Soc. N. S. Wales (2), iv, 1889, p. 179.

Heptranchus griseus Macdonald, Proc. Zool. Soc. Lond., Sept. 15, 1873, p. 312. Off Flinders Id., Bass Strait. New name for *H. indicus* Macdonald and Barron, 1868 [anticipated by Agassiz, 1835]. Not *Hexanchus griseus* Rafinesque, 1810, from Europe; regarded as congeneric, in *Notidanus*, by Günther.

* For No. 4 see RECORDS OF THE AUSTRALIAN MUSEUM, Vol. xviii, No. 3, 1931, p. 96.

Notidanus (Heptanchus) indicus McCoy, Prodr. Zool. Vict., dec. v, 1880, p. 16, pl. xliii, fig. 2 (Hobson's Bay, Victoria).

? *Heptranchias pectorosus* Garman, Bull. Essex Inst., xvi, 1884, p. 56 (13 of reprint). Patagonia (*fide* Garman, 1913).

? *Heptranchias haswelli* Ogilby, Proc. Linn. Soc. N. S. Wales, xxii, 1, Sept. 17, 1897, p. 62. Cape of Good Hope?

Heptranchias indicus Waite, Rec. Canterb. Mus. i, 1907, p. 6 (New Zealand).

Notorhynchus indicus Zietz, Trans. Roy. Soc. S. Austr., xxxii, 1908, p. 289 (S. Australia).

Notorynchus pectorosus Garman, Bull. Mus. Comp. Zool. Harv., xxxvi, 1913, p. 20.

Notorhynchus pectorosus McCulloch, Austr. Zool., i, 7, 1919, p. 219, fig 3a.; Austr. Zool. Handbook, i, 1922, p. 4, fig. 3a. *Id.* Waite, Rec. S. Austr. Mus., ii, 1, 1921, p. 10, fig. 5; Fish. S. Austr., 1923, p. 24 and figs. *Id.* Phillipps, N.Z. Journ. Sci. Tech., vi, 1924, p. 259, fig. 1 (Hokitika, New Zealand).

Notorynchus griseus McCulloch, Austr. Mus. Mem., v, 1929, p. 3.

Heptranchias macdonaldi Ogilby MS.

Total length 1,990 mm. or 78 in. Width of head (280 mm.) equal to its length, measured from tip of snout to first gill-opening. Eye 30 mm. Interorbital 173. Snout to origin of dorsal 1,010. Caudal 655. Pectoral 270. Dorsal 173, its base 150. First gill-opening 130; last 73. Posterior margin of eye to spiracle 110. (Fins measured from anterior origin to tip.)

Snout broadly rounded. Nostrils in a notch on anterior profile. Margin of eye free. No nictitating membrane. Spiracle very small, a considerable distance behind eye. Two similar openings, close together, on top of head. Gape of mouth extending to beyond vertical of eye, but not so far as vertical of spiracle. A median tooth in both jaws. Teeth of upper jaw curved and acutely pointed, the lateral ones with one or more pointed cusps on their outer sides and often a smaller inner cusp. A triangular pocket of skin on each side of rictus. Teeth of lower jaw comb-like, with five or six sharp cusps, the shoulder of the first and largest cusp of each tooth serrated. Gill-slits seven, the first largest, and the last slanting over the origin of the pectoral.

General form elongate, broadest near shoulders; axis of tail not very much elevated. Lateral line present on upper part of sides, extending to lower half of tail and then ascending along base of lower caudal lobe. One dorsal fin, situated over interspace between ventrals and anal. Caudal elongate, with a very long lower lobe, separated from the tip by a notch. No caudal pits. Body covered with rough shagreen which forms prominent denticles on upper surface of tail. A large papilla at each abdominal pore immediately behind the anus.

General colour grey above, whitish below. Widely spaced, round, white spots, larger than pupil, on back and paired fins. Head, body, tail and most of fins with large speckles of dark grey.

Described and figured from the female holotype, 78 inches in total length, from Manly, New South Wales, August 20, 1930; presented by the late E. W. Scott. Austr. Mus. regd. no. IA.4640.

Small copepod parasites on roof of mouth. No identifiable stomach contents. No embryos.

This specimen agrees fairly well with Müller and Henle's figure of *Heptanchus indicus*, but has the ventral fins nearer the dorsal. No white spots on the back are shown in their figure, but they are most conspicuous in my specimen. Macdonald

and Barron stated that white spots were present in a male and absent in a female, and suggested that they might have been the result of disease.

Nomenclature.—Macdonald and Barron gave an excellent description and plate of the Seven-gilled Shark of Bass Strait, which they called *Heptranchus indicus*, quoting no authority for the specific name. The identity of this species with the supposedly congeneric *Notidanus indicus* Agassiz[1] was disputed by Garman (1913). In 1873, Macdonald referred to the Bass Strait specimens as *Heptranchus griseus*, without stating that this was a new name, or perhaps regarding it as conspecific with the European *Squalus griseus* Gmelin or *Hexanchus griseus* Rafinesque, Günther's "Catalogue," with these names in *Notidanus*, having been issued in the meantime. Apparently the Australian form has no name of its own, so I am proposing one here which was suggested in a letter from J. D. Ogilby to A. R. McCulloch, dated October 22, 1909, as follows: "I have long been of opinion that our *Heptranchias* requires a new name and so list it as *H. macdonaldi*; however, as it does not occur here [Queensland], I hand it over unreservedly to you." To this, McCulloch had appended a note in his card-index: "We have received a small specimen from Port Jackson which accurately agrees with Müller and Henle's figure of *H. indicus*. Macdonald and Barron's figure in P.Z.S. of a specimen from Bass Straits is very good, and there should be little difficulty in deciding if it is correctly identified." It has thus remained for the present writer to instate Ogilby's name, which does not appear to have been published hitherto.

Family ISURIDÆ.

Genus **Isuropsis** Gill, 1862.

Isuropsis, sp.

(Plate xx, figs. 1–2.)

Lamna glaucus Günther, Cat. Fish. Brit. Mus., viii, 1870, p. 391. Cape and St. Helena. Not *Oxyrhina glauca* Müller and Henle, Syst. Plagiost., 1839, p. 69, pl. xxix, from Japan.

Lamna glauca Gilchrist, Mar. Invest. S. Afr., i, 1902, p. 163. *Id.* Thompson, Mar. Biol. Rep., ii, Cape Town, 1914, p. 145.

Isurus glauca Barnard, Ann. S. Afr. Mus., xxi, 1925, p. 33 (not fig.).

Head (314 mm.) 3·3 in length from snout to middle of caudal margin (1040). Depth (195) 5·6 in same. Eye (25) 3·6 in snout (90). Snout, measured from nostril (62), 1·6 in mouth (103). Distance from anterior border of nostril to that of eye (32) 4·4 in distance from posterior margin of eye to first gill-slit (142). Interocular width (71) 1·1 in length of snout from level of anterior margins of eyes (81). Internarial space (44·5) 1·1 in distance from nostril to end of snout (62). Length of anterior teeth of lower jaw (13) 1·9 in eye.

Base of first dorsal, 105 mm.; its height (94) 3·2 in head and less than half depth of body. Second dorsal and anal fins small, subequal.

Base of pectoral, 75 mm.; outer length 184; inner length 37, height 169. Base of ventral 58 mm. Upper caudal lobe 218 mm., lower 170, or 1·28 in upper.

Axilla of pectoral to origin of ventral, 265 mm. Vertical of dorsal origin 65 mm. behind pectoral axilla. Termination of first dorsal to origin of second, 308 mm. Origin of anal to that of ventral, 200. Width of caudal peduncle, including

[1] Agassiz.—Rech. Poiss. Foss., 1835, p. 71, pl. E, fig. 1.

keel, measured half-way between the second dorsal and the caudal, 89 mm.; depth of same, 46.

General shape fusiform, with the snout acutely pointed and the caudal peduncle depressed. Head and body covered with very fine denticles which give in places a sheen comparable to satin. No denticles around pectoral or ventral axillæ. Head one-third of length without caudal, depth about five in same.

Teeth in two functional series flexuous, interjacent, backwardly directed, longest in front of lower jaw, prismatic, with trenchant anterior edges. No basal denticles, no teeth at symphyses.

Dental formula: $\frac{10+10}{10+10}$

Palate much plicated. Tongue free, rounded, occupying most of space between teeth in lower jaw. Mouth longer than snout. Upper lip retractile. Nostril above anterior border of jaw. First dorsal originating behind the vertical of the pectoral base, but nearer pectoral than ventral. Second dorsal slightly in advance of anal. A precaudal pit above and below.

Colours.—Dark leaden bluish-grey above, whitish below; the junction between the colours fairly well marked.

Described and figured from an immature female, 47 inches in length and originally weighing 27 pounds. Austr. Mus. regd. no. IA.4311; specimen cast.

Locality.—Cape district, South Africa; presented by the South African Museum, Cape Town.

Mr. W. J. Phillipps informs me that he has found $\frac{13+13}{13+13}$ teeth in a pair of jaws of this species sent to him from South Africa by Mr. C. Biden. I leave this South African form unnamed for the present, but it appears to be closely allied to the Japanese *Isuropsis glaucus* (Müller and Henle) and the "mako" shark, *I. mako* (Whitley) from New Zealand.

Family RAJIDÆ.

Genus **Raja** Linné, 1758.

Subgenus **Cephaleutherus** Rafinesque, 1810.

Cephaleutherus Rafinesque, Indice Ittiol. Sicil., 1810, p. 61. Haplotype, *C. maculatus* Rafinesque, *fide* Gill, Proc. U.S. Nat. Mus., xviii, 1896, p. 195.

? *Propterygia* Otto, N.A. Ac. Cæs. Leop. Car., x (1), 1820, p. 120 (*fide* Sherborn, Index Anim.). Type, *P. hyposticta* Otto; a deformed *Raja* (*fide* Jordan, Gen. Fish., i, 1917, p. 117). Also spelt *Propleygia* by Gray, 1851 (*fide* Gill).

Hieroptera Fleming, Edinb. New Phil. Journ., xxxi, Oct., 1841, p. 237 (*fide* Sherborn). Orthotype, *H. abredonensis* Fleming; a monstrous *Raja clavata* Linné (*fide* Jordan, Gen. Fish., ii, 1919, p. 209). *Id.* Agassiz, Nomencl. Zool., 1846, Pisces, p. 30, and Index Univ., p. 182; wrongly attributed to Rafinesque, 1810 (Sherborn). *Id.* Radcliffe, Nat. Hist., xxviii, 1, 1928, p. 61, fig. 4 (after Fleming).

Peroptera Gistel, Nat. Thierr. höh. Schulen, 1848, p. x. New name for "*Perioptera*, Nob. deleatur." *Id.* Jordan, Proc. Acad. Nat. Sci. Philad., lxx, 1918 (1919), p. 339; and Gen. Fish, ii, July, 1919, p. 238. Not *Peropterus* Partington, 1837 (*fide* Sherborn).

Perioptera Gistel, Nat. Thierr. höh. Schulen, 1848, p. x. *Nomen nudum. Id.* Waterhouse, Index Zool., 1902, p. 278.

Raja subg. *Hieroptera* Jordan, Copeia, 142, 1925, p. 37.

Gistel's genus *Peroptera* or *Perioptera* has apparently never been precisely determined, but it seems that these names are merely mis-spellings of *Hieroptera* Fleming, Agassiz. Agassiz was frequently quoted by Gistel, who probably utilized the "Nomenclator Zoologicus" when compiling the lists of genera supplementing his main work in the Nat. Thierr. I therefore regard *Perioptera* and *Peroptera* as synonyms of *Hieroptera*, which is itself apparently synonymous with *Cephaleutherus* and probably also with *Propterygia*. These abnormal rays, in which the pectoral fins are separated from the head, have been recently dealt with by Popov in the Bull. Acad. Sci. URSS and by Radcliffe, the last of whose examples is one of the artificially distorted specimens known as Jenny Hanivers.[2]

Family CLUPEIDÆ.

Genus **Harengula** Cuvier and Valenciennes, 1847.

Harengula lippa, sp. nov.

(Figure 1.)

D.18; A.21; P.17; V.8, C.19; Sc. less than 40. L.tr.12.

Head (33 mm.) 3·8, depth of body (39·5) 3·1 in length to hypural joint (126).

Eye large, with adipose lids. Mouth lateral, maxillary with two supplemental bones and reaching backwards to below pupil of eye. Minute teeth on jaws and palatines. Vertex of head and, to a less extent, opercula striated. Form elongated, belly compressed and serrated. Scapular area smooth, like sides of head. Body covered with large striated scales with their vertical lines interrupted in the

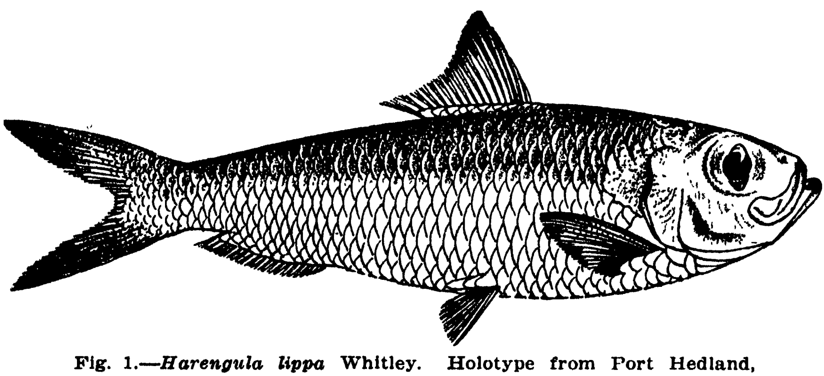

Fig. 1.—*Harengula lippa* Whitley. Holotype from Port Hedland, North-western Australia. Drawing by A. R. McCulloch.

middle. No lateral line. Fifteen preventral and fifteen postventral scales. Less than 40 transverse series of body scales between shoulder and hypural joint. About eleven predorsal scales. Dorsal unique, its origin nearer to snout than to caudal peduncle. Anal short, low, continuous, without produced posterior rays. Pectorals thoracic. Ventrals well developed, their origin behind that of dorsal. Caudal forked.

[2] Whitley.—Austr. Mus. Magazine, iii, 8, 1928, p. 262, 5 figs.

General colour silvery, dark greyish above, with top of head, tip of jaws, and lobes of dorsal and caudal dusky.

Described and figured from the holotype, a specimen 126 mm. in standard length or about 6½ inches in total length. Aust. Museum regd. no. I.12828; W. Aust. Mus. No. P.18.

Locality.—Port Hedland, North-western Australia; received by exchange from the Western Australian Museum in 1913.

This species is allied to *Harengula bulan* (Bleeker, 1849), but differs notably in having more anal rays.

Harengula macculiochi, sp. nov.

(Figure 2.)

D.17; A.22; P.17; V.8; C.18; Sc. less than 40 between shoulder and hypural joint. L.tr.12.

Head (38 mm.) 3·3, depth of body (46) 2·7 in length to hypural joint (127).

Eye large, with adipose lids. Minute teeth on jaws and palatines; a group of larger teeth on mandibles anteriorly. Vertex of head, and, to a less extent, opercula, striated. Body rather deep, the lower profile more convex than the upper. Belly compressed and serrated. Scapular area smooth, like most of the head. Body-scales large, deciduous, with the margins striated or irregular, and the subvertical

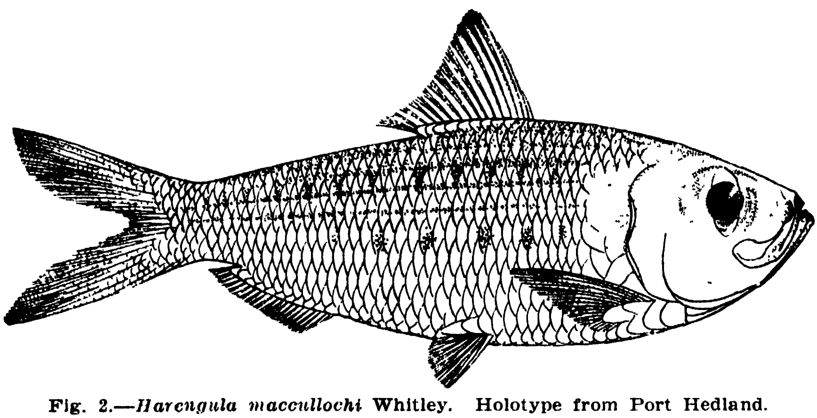

Fig. 2.—*Harengula maccullochi* Whitley. Holotype from Port Hedland. North-western Australia. Drawing by A. R. McCulloch.

lines mostly extending from top to bottom of each scale. Seventeen preventral and twelve postventral scutes and about nine predorsal scales.

Dorsal unique, its origin nearer to tip of snout than to caudal peduncle. Anal without modified posterior rays. Pectorals long, nearly reaching ventral origin, which is below the anterior half of the dorsal fin. General colour silvery, dark greyish above. Some horizontal dusky bars and a row of about thirteen dusky spots along upper part of sides; another row of about six similar ones below them anteriorly. Tips of snout, dorsal, and caudal lobes brownish.

Described and figured from the holotype, a specimen 127 mm. in standard length or about 6½ inches in total length. Aust. Mus. regd. no. I.12827; W. Aust. Mus. no. P.17.

Locality.—Port Hedland, North-western Australia; received by exchange from the Western Australian Museum in 1913.

Distinguished from *Harengula lippa* by its deeper body, different fin and scale counts, and coloration. This new species is a western ally of *Harengula koningsbergeri* (Weber and Beaufort, 1912) from the Aru Islands, but has fewer predorsal scales and dorsal rays and more anal rays.

Named after the late Allan R. McCulloch, who made the drawings of the two new species of *Harengula* here described.

Genus **Amblygaster** Bleeker, 1849.

Amblygaster posterus, sp. nov.

D.17; A.14 + 2; P.16; V.9; C. 15; Sc. *circa* 40. L.tr.11.

Head (49 mm.) nearly 3·6, depth (42) 4·19 in standard length (176).

Eye partly concealed by adipose lids which unite with the skin to give most of the sides of the head a gelatinous appearance. Maxillary extending to below pupil. Teeth on palate and tongue. Border of upper jaw slightly incised. Jaws apparently toothless. Vertex of head with dense patches of striæ behind the eyes. Gill-rakers, fine, elongate, very numerous. Form elongate, robust. Belly not strongly compressed, but with the median ventral scales keeled. Scapular region scaleless and, like parts of the opercula, venulous. Body-scales striated, with the subvertical lines not meeting in the middle of each scale. 20 preventral and 15 postventral scutes; about 17 predorsal scales. Dorsal originating nearer to tip of snout than to caudal peduncle. Two posterior anal rays enlarged. Base of anal fin longer than that of dorsal. Bases of anal and caudal fins very scaly. Ventrals originating below median rays of dorsal. Pectorals subfalciform, almost equal in length to head without snout.

General colour, after long preservation, silvery on the sides, dark greyish above.

Described from the holotype, a specimen 176 mm. in standard length or 8¾ inches in total length. Austr. Mus. regd. no. I.12826; W.A. Mus., no. 10710. This is the largest of a series of six specimens 7¾ inches or more in length.

Locality.—Fremantle District, Western Australia; received by exchange from the Western Australian Museum (holotype) and collected by Mr. A. Abjornson of the Fisheries Department of W. Australia (paratypes).

Family SPHYRÆNIDÆ.

Genus **Sphyræna** Bloch and Schneider, 1801.

Sphyræna leveriana (Shaw).

Gadus leverianus Shaw, Gen. Zool., Pisc., iv, 1, 1803, p. 153. Southern Ocean. *Id.* Swain, Proc. Acad. Nat. Sci. Philad., 1882 (1883), p. 304.

Gadus leverianus Shaw was supposed to have come from the "Southern Ocean," collected on Cook's last voyage. Swain was unable to identify this species and other authors seem to have ignored it. If it was really collected on Cook's last voyage, it was evidently not Australian, but perhaps from one of the Pacific islands. Cook[8] mentions, amongst other fishes, "a sort of Pike" caught at Tongatabu in July, 1777, which may be this species. I classify this little known

[8] Cook.—Voy. Pacif. Ocean, i, 1784, p. 335.

species in the genus *Sphyræna* as commonly understood. It is unfortunate that no fishes were included by Shaw in his excellent "Museum Leverianum," published 1792-96, or perhaps the problem of its identity would not have arisen.

Family PTERACLIDÆ.

Genus **Pteraclis** Gronow, 1772.

Pteraclis Gronow, Actæ Helveticæ, vii, 1772, p. 43, pl. xi, fig. 1. Orthotype, *P. pinnata* Gronow = *Coryphæna velifera* Pallas (*fide* Jordan, Gen. Fish., ii, 1919, p. 168). Not seen. *Id.* Oken, Lehrb. Naturg., iii (2), 1816, p. 23 (*fide* Sherborn, Index Anim.). *Id.* Cuvier, Règne. Anim. ed. 1, ii, "1817" = Dec., 1816, p. 329. *Id.* Schinz, Das Thierreich (Cuvier), ii, 1822, p. 527. *Id.* Jarocki, Zoologiia, iv, 1822, p. 298 (*fide* Sherborn). *Id.* Cuvier and Valenciennes, Hist. Nat. Poiss., ix, 1833, pp. 359 and 363. *Id.* Swainson, Nat. Hist. Classif. Fish, Amphib. Rept., ii, July, 1839, p. 47. *Id.* Gray, Cat. Fish. coll. Gronow Brit. Mus., 1854, p. 170. *Ex* Gronow MS. *Id.* Günther, Cat. Fish. Brit. Mus., ii, 1860, p. 410. *Id.* Jordan, Proc. Acad. Nat. Sci. Philad., 1918 (1919), p. 343, and Ann. Carneg. Mus. xii, 1919, p. 331.

Pteridium Scopoli, Intr. Hist. Nat., 1777, p. 454. Haplotype *Coryphæna vellifera* [sic] Pallas. Not *Pteridium* Swainson, Nat. Hist. Classif. Fish. Amphib., Rept. i, 1838, p. 323; Filippi and Verany, 1855; Günther, 1862 = *Oligopus* Risso, 1810 = *Verater* Jordan, Proc. Acad. Nat. Sci. Philad., 1918 (1919), p. 343, a genus of brotulid fishes.

Oligopodus Lacépède, Hist. Nat. Poiss. ii, 1800, p. 511, Haplotype, *O. veliferus* Lacépède, based on *Coryphæna velifera* Gmelin [= Pallas]. Not *Oligopodes* Cuvier, Règne Anim. ed 1, ii, "1817" = Dec., 1816, p. 323 = *Oligopodus* Schinz, Das Thierreich (Cuvier), ii, 1822, p. 526 = *Verater* Jordan, Proc. Acad. Nat. Sci. Philad., 1918 (1919), p. 343, a genus of brotulid fishes.

Pteraclidus Rafinesque, Anal. de la Nature, 1815, p. 82, substitute for *Oligopodus* Lacépède, 1800 (*fide* Jordan, Gen. Fish., i, 1917, p. 88).

? *Oligopus* Minding, Lehrb. Naturg. Fische, 1832, p. 88. Variant of *Oligopodus* Lacépède (*fide* Sherbon). ? not *Oligopus* Risso, Ichth. Nice, 1810, p. 141 = *Verater* Jordan, Proc. Acad. Nat. Sci. Philad., 1918 (1919), p. 343, a genus of brotulid fishes.

Pteracles Swainson, Nat. Hist. Classif. Fish, Amphib. Rept., i, Oct., 1838, pp. 20 and 41, *et ibid*, ii, July, 1839, pp. 178 and 257. Error for *Pteraclis*.

Pteroclidus Agassiz, Nomencl. Zool., 1846, Index Univ., p. 314. Emendation for *Pteraclidus* Rafinesque, 1815.

Pteroclis Agassiz, Nomencl. Zool., 1846, Index Univ., p. 314. Emendation for *Pteraclis* Cuvier and Valenciennes, 1833 [= Gronow 1772].

In his "Genera of Fishes," and in earlier papers, Jordan quoted the Zoophylacium of Gronow as the work in which *Pteraclis* was first proposed, but this generic name does not appear either in the Zoophylacium (1763) or Meuschen's Linnean index thereto (1781).

Oligopus Risso, 1810, is not congeneric with *Oligopodus* Lacépède, 1800; it is a brotulid fish called *O. ater* in 1810 and *O. niger* in 1826 by Risso. "Les Leptopodes" Cuvier, 1816, vernac., *Oligopodes* Cuvier, 1816, *Leptopodus* Schinz, 1822 (not *Leptopus* Rafinesque, 1814, another genus of fishes), *Oligopodus* Schinz, 1822 (not Lacépède, 1800), *Oligopus* Swainson, 1838, *Pteridium* Swainson, 1838, Filippi

and Verany, 1855, and Günther, 1862 (not Scopoli, 1777), are congeneric with *Oligopus* Risso, 1810, but as none of these names is available, this brotulid genus may be known as *Verater* Jordan, 1919.

Bentenia Jordan and Snyder[4] is of doubtful generic status and may be employed as a subgenus for the Japanese species. *Pteraclis velifer* has been figured by Bonnaterre, after Pallas, with the compressed dorsal and anal spines which are supposed to distinguish *Bentenia*.

Pteraclis velifer (Pallas).

Coryphæna velifera Pallas, Spicilegia, viii, 1770, p. 19, pl. iii, fig. 1. "Mers des Indes" = Moluccas (*fide* Cuvier). *Id.* Bonnaterre, Tabl. Encycl. Meth. Ichth., 1788, p. 60, pl. xxxiv, fig. 128 (after Pallas). La Mer des Indes.

Pteraclis pinnata Gronow, Acta Helvet., vii, 1772, p. 44, pl. xi, fig. 1 (*fide* Sherborn, Index Anim.). Not seen.

Coryphæna vellifera (sic) Scopoli, Intr. Hist. Nat., 1777, p. 454. *Ex* Pallas, 1770.

Coryphæna velifera Gmelin Syst. Nat. (Linné), ed. 13, i, 3, 1789, p. 1193. *Ex* Pallas. Southern Indian Ocean.

Oligopodus veliferus Lacépède, Hist. Nat. Poiss., ii, 1800, pp. 511 and 512. Mers des Indes.

Pteraclis velifra (sic) Bloch and Schneider, Syst. Ichth., 1801, p. 143, pl. xxxv; not good—*fide* Cuv. and Val.

Pteraclis guttatus Cuvier and Valenciennes, Hist. Nat. Poiss., ix, 1833, p. 370. New name for *Coryphæna velifera* Pallas.

Pteraclis pinnata Gray, Cat. Fish. coll. Gronow Brit. Mus., 1854, p. 170. *Ex* Gronow MS. Indian Ocean.

Pteraclis velifer Günther, Cat. Fish, Brit. Mus., ii, 1860, p. 411.

Typical species of the genus from the "Southern Indian Ocean."

Pteraclis (Bentenia) sp.

Pteraclis velifer Ogilby, Rec. Austr. Mus., ii, Sept., 1893, p. 65. New Zealand. *Id.* Waite, Rec. Canterbury Mus., i, 1, 1907, p. 25.

Pteraclis velifera Phillipps, Journ. Pan-Pacif. Res. Inst., ii, 1927, p. 13, and N.Z. Mar. Dept. Fish. Bull., i, 1927, p. 35. N. Zealand; listed only. Not *Coryphæna velifera* Pallas, 1770.

Pteraclis sp. nov. Phillipps, *in lit.* July 21, 1930.

D.57; A. *circa* 50; P.19; V1/3; C.15 branched rays.

Head (76 mm. maximum, or 70 from symphyses) a little over 5 in total length, subequal to pectoral. Eye (20 mm.) equal to snout, nearly 4 in head. Maxillary 33 mm. Width between anterior orbital borders 15 mm. Depth of body, excluding sheaths, 80 mm.; depth of largest sheath scales 11 mm.

Profile obliquely rounded, forehead anterior. Head scaly except on eyes, chin and anterior part of preorbital. Nostrils slightly above horizontal of middle of eye. Opercula broadly rounded. Eight pointed gill-rakers on lower limb of first gill-arch, the longest about one-fourth diameter of eye. An outer and inner row of spaced, simple, curved teeth in each jaw, and a similar row on each palatine. No teeth on vomer, symphyses, or tongue.

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[4] Jordan and Snyder.—Journ. Coll. Sci. Tokyo, xv, 1901, p. 306. Orthotype, *B. æsticola* J. and S. Jordan.—Ann. Carnegie Mus., xii, 1919, p. 331.

Body elongate, strongly compressed and tapering, covered with thin leaf-like scales, most of which have an apical notch, in about 52 rows between operculum and hypural joint. The body-scales are largest posteriorly but there is a row of very large scales forming a sheath on either side of the dorsal and anal fins. Scales adherent and with fine longitudinal striations.

Dorsal fin originating at tip of snout; anal originating below eye. Both these fins have long bases and are composed of spines which are short posteriorly but very long anteriorly, almost reaching the caudal when adpressed. Some of them are unfortunately broken in my specimens. Third and fourth dorsal and first and second anal and pectoral spines compressed. Ventral spine filiform, the rays small. Pectorals pointed. Caudal strongly forked. The fins are fragile and all are to some extent damaged.

General colour, after long preservation in "acid" and later in alcohol, dark green with the scales silvery and the membranes of the dorsal and anal uniform brown.

Described from a specimen 340 mm. in length to hypural or about 15¼ inches in total length. Austr. Mus. regd. no. I.2980.

Loc.—New Zealand; purchased 1891.

There is a second New Zealand specimen in the Australian Museum (No. I.2915); only the head and anterior part of body and fins have been preserved. This specimen has a few teeth on vomer, seven branchiostegals, anterior anal membranes whitish distally, and numerous small circular white spots on dorsal and anal membranes.

Ogilby was the first to record *Pteraclis* from New Zealand and the specimens described above were doubtless the basis of his record.

So far as may be gleaned from a study of the literature on *Pteraclis* and in the absence of more specimens, it can only be said that the New Zealand species shows only minor variation from *P. velifera*, but I leave it specifically unnamed as my colleague, Mr. W. J. Phillipps, intends to deal with further New Zealand specimens, which he regards as belonging to a new species.

Family ISTIOPHORIDÆ.

Genus **Istiompax** Whitley, 1931.

Istiompax Whitley, Austr. Zool., vi, 4, Feb. 13, 1931, p. 321. Orthotype, *I. australis* Whitley.

In the Black Marlin Swordfish of New South Wales, the type of this genus, the anterior spines of the first dorsal fin are much longer than the posterior. This feature separates *Istiompax* from *Istiophorus* Lacépède, 1802 (synonyms: *Nothistium* Herrmann, *Histiophorus* Cuvier, and *Notistium* Jordan) and *Zanclurus* Swainson, 1839. *Makaira* Lacépède, 1803, is based on an unsatisfactory diagnosis of a European swordfish which appears very dissimilar from our Black Marlin. *Tetrapturus* Rafinesque, 1810 (syn. *Tetrapterus* Agassiz and *Skeponopodus* Nardo), is said to be based on *T. belone* Rafinesque, but Cuvier and Valenciennes' figure of this species shows a fish with the posterior dorsal rays about half as long as the anterior, whereas they are much less than that in *Istiompax*. *Marlina*[5] Grey, 1928, is distinguished by its striped body and reduced scales, and the Striped Marlin Swordfish of New Zealand, which has been called

[5] Grey.—Natural History, xxviii, 1, 1928, p. 47. Haplotype, *M. mitsukurii* Jordan and Snyder. See also Whitley, Rec. Austr. Mus., xvii, 3, 1929, p. 101.

Makaira mitsukurii, would be better termed *Marlina zelandica* (Jordan and Evermann) on zoogeographical grounds. A new generic name may be required for the Japanese swordfish figured by Tanaka[6] with its elevated posterior dorsal spines, short snout and short pectorals.

Probably the Black Marlin Swordfishes of New South Wales, Tasmania and New Zealand are conspecific, as they are migratory fishes. For the present, they may be called *Istiompax australis*, but as actual comparison of specimens is at present impracticable, I restrict the following account to the New South Wales species, which I have studied from excellent specimens. A series of measurements from three examples is given in the hope that further such series may be drawn up from other specimens for comparison when opportunity arises.

Istiompax australis Whitley.

Histiophorus gladius Ramsay, Proc. Linn. Soc. N. S. Wales, v, 3, Feb., 1881, pp. 295 and 522, pl. viii. Male holotype of *Istiompax australis* Whitley, 13 ft. 4 in. long, in the Australian Museum. Off Wollongong, New South Wales; July 4, 1880. *Id.* Tenison-Woods, Fish. Fisher. N. S. Wales, 1882, p. 55. Not "*Scomber gladius* Broussonet, Mem. Acad. Sci., 1786, p. 454, pl. x," which, according to authors, is a species of *Istiophorus*, but Mr. C. D. Sherborn states (*in lit.*) "Pure invention, no such name occurs." I have not seen this paper.

Tetrapturus indicus Waite, Mem. Nat. Club N.S.W., 1904, p. 42 (N.S.W.). *Id.* Stead, Fish. Austr., 1906, p. 170, fig. 61 (Manly, N.S.W.). *Id.* Stead, Edib. Fish. N. S. Wales, 1908, p. 100, pl. lxvii (Port Jackson, N.S.W.). *Id.* McCulloch, Austr. Zool., ii, 1921, p. 80; Austr. Zool. Handbook, i, 1922, p. 80, pl. xxxiv, fig. 297a. Not *T. indicus* Cuv. and Val., 1831, from "southern seas."

Makaira mazara Griffin, Trans. N.Z. Inst., lviii, 1927, p. 141, pl. xiii, fig. 5. *Id.* McCulloch, Austr. Mus. Mem., v, 2, 1929, p. 266. Not *Tetrapturus mazara* Jordan and Snyder, 1901, from Japan.

Tetrapturus herschelii McCulloch, Austr. Mus. Mem., v, 1929, p. 266. Not *Tetrapturus herschelii* Gray, 1838, from South Africa.

Istiompax australis Whitley, Austr. Zool., vi, 1931, p. 321. Off Wollongong, N.S.W. Type in Austr. Mus. [Ex *Tetrapturus australis* Macleay MS.]

The fin-formulæ and measurements, from which the proportions may be worked out, are given in the accompanying table.

Some scales behind eye and on cheeks and temples; rest of head naked. Scattered rudimentary scales on eye and between dorsal spines. Rugose teeth on jaws, vomer, palatines, tongue, gill-arches, etc. The small free portion of tongue with rounded margin. A peg behind gill-cover. The skin of the body closely set with elongate, curved scales. Lateral line present as a naked streak with minute close-set pores; it extends in a straight line along the centre of the body from the middle of the caudal peduncle to above the middle of the pectoral, where it curves upwards to the angle of the operculum.

General colour of a specimen from Manly, N. S. Wales, light bluish-grey, without vertical stripes. First dorsal fin brownish, with some dark spots between lower halves of spines. Second dorsal greyish.

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[6] Tanaka.—Fishes of Japan, xviii, Nov. 18, 1914, pl. lxxxviii, fig. 285; xix, Feb. 28, 1915, p. 324, as *Tetrapturus angustirostris*.

Colour of a Port Stephens specimen noted by McCulloch and later macerated, dark slate above, silvery white below. All the lower half, including the fins, with traces of bright silver. Side of head, branchiostegals, and a triangular patch behind the pectorals, silver. Bony portion of eye silver; iris golden. Dorsals dark slaty black, similar to the pectorals, ventrals, and caudal fins. Anal fins lighter in tone.

	Ramsay's (and my) type from Wollongong, N.S.W.	Specimen from Manly, N.S.W.	Small Specimen from Port Stephens, N.S.W.
	Ft. In.	Ft. In.	Ft. In.
Total length to end of middle caudal rays	13 4	13 1	6 3½
Total length to tip of tail	14 0	—	6 8
Upper lobe of caudal fin } from {	2 9	2 8	—
Lower lobe of caudal fin } caudal pits {	2 7	2 6	—
Breadth of expanded caudal ..	—	—	2 1¾
Length of caudal keel	0 5½	0 4½	—
Depth of caudal keel..	0 2½	0 1½	—
Height of body opposite dorsal fin ..	2 6	1 10½	0 11
Height of body at origin of anal fin ..	—	—	0 9
Height of first dorsal from base ..	1 6	1 0½	—
Height of second dorsal from base ..	0 5	0 3	longest (4th) ray, 8¾ in. 7th ray, 6 in.
Extent of second dorsal at base ..	1 2½	0 8	—
Length of pectoral fin	2 4	2 2	1 1½
Its width at the base	0 7	0 5	—
Its width four inches from the body	0 5	0 4½	—
Length of ventral fin..	—	—	0 10¾
Snout from nostril	2 7	2 7½	—
Length of head from nostril to hinder margin of gill-cover	1 8	1 9	—
Length of head, with snout.. ..	4 5	4 4½	2 2½
From tip of snout to centre of eye ..	2 10	2 10½	1 6
From centre of eye to gill-cover ..	1 4½	1 6	—
First anal fin	1 2	—	—
Second anal fin	0 4½	0 6 (last ray)	—
Breadth of body at first anal .	2 0	—	—
Least depth of caudal peduncle ..	—	—	0 2¾
Length of lower mandible to gape..	1 4½	1 7	—
Lower mandible to gill-cover ..	1 9	3 0	1 4½
Snout projects beyond lower jaw ..	—	—	0 10
Tip of snout to pectoral fin.. ..	2 2½	4 4½	—
Tip of snout to first dorsal.. ..	4 0	3 10	—
Tip of snout to gape..	3 2	2 11½	—
Horizontal diameter of orbit ..	0 3	0 3	0 1¾
Vertical diameter of orbit	0 2	0 2¾	0 1½
Dorsal formula..	35/7	35/2/9(10)	39/7
Anal formula	12–13/6	?	14/7
Ventral formula	1	1	1/1
Pectoral formula	?	?	20
Branchiostegals	—	—	7

Description and dimensions based on three specimens from the following localities:

Off Wollongong, New South Wales; July 4, 1880. Holotype of *Istiompax australis* Whitley, figured by Ramsay. Male, 13 ft. 4 in. long, in Australian Museum.

Manly, near Sydney, New South Wales; Sept., 1930. A specimen 13 ft. 1 in. long, not preserved, but examined by the writer when fresh.

Port Stephens, New South Wales; date? Small example, 6 ft. 3½ in. long.

The last specimen was received by the late A. R. McCulloch from Dr. M. Lidwill and was regarded by him as belonging to the same species as Ramsay's specimen. Dr. Lidwill supplied the following details:

"On the capture of this fish, there were two Remoræ sticking on to it, and the stomach was full of pilchards and worms about the thickness of a piece of

thread and about 2½ inches long. It was taken midway between Entrance to Port Stephens and Broughton Island, during a south-easterly gale. Caught on a rod by trailing a mullet at two knots about sixty yards behind boat, on fine steel piano wire on a treble hook; caught in the tongue and showed no fight. Seventy pounds weight when fresh and 6 feet 8 inches long."

Describing the capture of the Wollongong specimen, Ramsay remarks:

". . . . A large sword fish in pursuit of a schnapper got entangled in the anchor line which had become twisted round its snout, thereby affording an opportunity for Mr. Andrews to harpoon it . . . .; after towing the boat for several miles the animal became exhausted and was in turn towed ashore. Shortly after being harpooned the fish disgorged a number of large schnapper, . . [*Chrysophrys guttulatus*] . . . and finally threw out the stomach itself. During the engagement it was seen to leap several feet in height out of the water."

Precise details of the capture of the Manly specimen were not available.

I borrowed the specific name of this swordfish from the earliest account of it I could find. This was a manuscript note of a donation by Sir William Macleay in one of the old minute-books of the Australian Museum, as follows:

"*Tetrapturus australis* . . . . March 4, 1854. Broken Bay, N. S. Wales." Also "In August, 1854, The Sydney and Melbourne Steam Packet Company presented portion of the sword of a *Tetrapturus* found in the hull of S.S. *Governor General*, with a portion of the timber 3½ in. thick, with a written description of the particulars."

The parasites infesting this species have been noted in Ramsay's paper. The worms mentioned by Lidwill (*supra*) were doubtless nematoda. No parasites were observed on the Manly specimen.

Istiompax australis evidently feeds on oceanic fishes, such as the rocky coast-haunting snapper and the pelagic pilchard, but opinions differ as to its qualities as a game fish.

Family ACINACEIDÆ.

Genus **Thyrsites** Cuvier and Valenciennes, 1832.

? *Acinacea* Bory de St. Vincent, Voy. îles Afriq., i, 1804, p. 93; Dict. class. d'Hist. Nat. i, 1822, p. 93. Haplotype, *A. notha* Bory, which may be an incorrectly described *Thyrsites atun* (with 29 dorsal spines) from Africa. Name emended to *Acinaces* by Agassiz, 1846. Not *Acinaces* Gerstacker, 1858, a genus of Coleoptera.

"*Les Thyrsites*" Cuvier, Règne Anim., ed. 2, ii, April, 1829, p. 200. Vernac.

Thyrsites Cuvier and Valenciennes, Hist. Nat. Poiss., viii, "1831" = Jan., 1832, p. 196. Logotype, *Scomber atun* Euphrasen, selected by Gill, Proc. Acad. Nat. Sci. Philad., 1862, p. 126. *Id.* Voigt, Das Thierreich (Cuv.), ii, 1832, p. 281. *Id.* Baudement, Dict. Univ. d'Hist. Nat. (D'Orbigny), xii, "1861" = 1848 (*fide* Sherborn, 1899), p. 572. *Id.* Alcock, Cat. Deep-Sea Fish. Investigator, 1899, p. 41.

Leionura Bleeker, Nat. Tijdschr. Ned. Ind., xxi, 1860, p. 68. *Ex* Kuhl and van Hasselt MS. Haplotype, *L. esox* (K. and v. H.) Bleeker = *Thyrsites atun*.

Thersites McCoy, Prodr. Zool. Vict., dec. v, 1880, p. 19. Error for *Thyrsites*. Not *Thersites* Spence-Bate, 1857, a genus of Amphipoda; nor *Thersites* Pagen-

stecher, 1861, a genus of Entomostraca; nor *Thersites* Pfeiffer, Mal. Blätter, ii, Dec., 1855, or Jan., 1856, p. 141, a genus of Australian terrestrial mollusca.

Bleeker introduced *Leionura esox* as a nude name *ex* Kuhl and van Hasselt's manuscript illustration, in the synonymy of the South African *Thyrsites atun*, so the generic name *Leionura*, which has been generally overlooked, is hereby designated an absolute synonym of *Thyrsites* Cuv. and Val.

Thyrsites atun (Euphrasen).

"*Paracutas*" Cook, [Third] Voy. Pacific Ocean, i, 1784, p. 152 (New Zealand). Vernacular.

Scomber atun Euphrasen, K. Vet. Akad. Nya. Handl., xii, 1791, p. 315 (*fide* Sherborn, Index Anim.). Cape of Good Hope (type-loc.) and Java. *Id.* Lacépède, Hist. Nat. Poiss., v, 1803, p. 679, and as vernac. in Hist. Nat. Quadr. ovip., iii, 1836, suppl. p. 309.

Scomber dentatus Bloch and Schneider, Syst. Ichth., 1801, p. 24. *Ex* J. R. Forster MS. [Queen Charlotte Sound,] New Zealand. Dorsal spines 20-23. *Id.* Richardson, Rept. 12th meet. Brit. Assn. Adv. Sci., 1842 (1843), p. 20.

? *Acinacea notha* Bory de St. Vincent, Voy. îles Afriq., i, 1804, p. 93; Dict. Class. d'Hist. Nat., i, 1822, p. 93. Off the African coast.

Thyrsites atun Cuvier and Valenciennes, Hist Nat. Poiss, viii, "1831" = Jan., 1832, p. 196, pl. ccxix. Cape of Good Hope. Seven dorsal and six anal finlets. *Id.* Cuvier, Règne Anim. (disciples' ed.), 1836, pl. xlix, fig. 1. Seven dorsal and seven anal finlets, and high anterior dorsal. Cape of Good Hope. *Id.* Richardson, Rept. 12th meet. Brit. Assn. Adv. Sci., 1842 (1843), pp. 20 and 21. *Id.* Bleeker, Verh. Akad. Amsterdam, ii, 1855, p. 10. Tasmania. *Id.* Bleeker, Nat. Tijdschr. Ned. Ind., xxi, 1860, p. 68. Cape. *Id.* Günther, Cat. Fish. Brit. Mus., ii, 1860, pp. 350 and 527. Seven finlets and seven pyloric appendages. *Id.* Castelnau, Proc. Zool. Acclim. Soc. Vict., i, 1872, p. 103. Victoria. Six dorsal finlets. *Id.* Klunzinger, Sitzb. Akad. Wiss. Wien, lxxx, 1879, p. 375 (Murray R. and Hobson's Bay, Vict.). *Id.* Sauvage, Arch. Zool. Exper., viii, 1879, pp. 3 and 29 (St. Paul and Australia). *Id.* Johnston, Proc. Roy. Soc. Tasm., 1882 (1883), pp. 81 and 117; *ibid.*, 1890 (1891), p. 32. Tasmania; six finlets, vertebræ 37. *Id.* Lucas, Proc. Roy. Soc. Vict. (n.s.), ii, 1889 (1890), p. 23. *Id.* Tenison-Woods, Fish. Fisher N. S. Wales, 1882, p. 56. Tasmania; fishing. *Id.* Ramsay, Cat. Exhib. N. S. Wales Court Internat. Fisher. Exhib., 1883, p. 12. *Id.* Saville-Kent, Natural. in Austr., 1897, p. 170, pl. xxviii, fig. 2. *Id.* Anderson, Guide Fishing Tasm., 1900, p. 47. *Id.* Waite, Rec. Austr. Mus., v, 1903, p. 56 (Coogee, near Sydney; new record for N. S. Wales). *Id.* Stead, Fish. Austr., 1906, pp. 166 and 264, fig. 60. *Id.* Waite, Rec. Canterb. Mus., i, 1907, p. 24; *ibid.*, 1911, p. 235. New Zealand; feeds on *Hemerocœtes*. *Id.* Stead, Edible Fish. N. S. Wales, 1908, p. 99. *Id.* Johnston, Abstr. Proc. Linn. Soc. N. S. Wales, No. 280, Nov. 24 (publ. Nov. 26), 1909, p. i (Entozoa named and recorded from Australia). *Id.* McCulloch, Zool. Res. Endeavour, i, 1911, p. 80. Flinders Id., Bass Strait and west of Kingston, South Australia; new record for S.A. *Id.* Weber, Fische Siboga-Exped., 1913, p. 407. Makassar and Buru; perhaps a distinct species—G.P.W. *Id.* Regan, Brit. Ant. Exp. Zool., i, 1, 1914, p. 16; *ibid.*, i, 4, 1916, p. 144, pl. viii, figs. 1-3. Larvæ from Cape North, N.Z. About 35 vertebræ; 18-20 dorsal

spines. *Id.* Gilchrist, S. Afr. Mar. Biol. Rept., ii, 1914, p. 116 and fig.; *ibid.*, iii, 1916, pp. 8 and 23 (egg; habits and statistics in S. Africa; seven dorsal and anal finlets. *Id.* Waite and McCulloch, Trans. Roy. Soc. S. Aust., xxxix, 1915, p. 465. South Australia; poor condition. *Id.* Roughley, Fish. Austr. and Tech., 1916, p. 166. *Id.* Thompson, S. Afr. Mar. Biol. Rept., iv, 1918, p. 113. Refs. *Id.* McCulloch, Rec. Austr. Mus., xiii, 4, 1921, p. 139, pl. xxiv, fig. 2. Sydney; five, usually six, dorsal and six anal finlets. *Id.* Phillipps, N.Z. Journ. Sci. Tech., iv, 3, 1921, pp. 118 and 124. New Zealand; occurrence and spawning. *Id.* Waite, Rec. S. Austr. Mus., ii, 1921, p. 144, fig. 226. S. Australia, but a New Zealand specimen, with seven dorsal and six anal finlets, is figured. *Id.* Phillipps and Hodgkinson, N.Z. Journ. Sci. Tech., v, 2, 1922, p. 94. Auckland, N.Z.; spawns in August. *Id.* McCulloch, Austr. Zool., ii, 1922, p. 107, fig. 301*a*; Austr. Zool. Handbook, i, 1922, p. 81, fig. 301*a*. N.S.W. *Id.* Fowler, Proc. Acad. Nat. Sci. Philad., lxxv, 1923, p. 43. Melbourne. *Id.* Waite, Fish. S. Austr., 1923, pp. 109 and 167, fig. Vernac. names and fishing. *Id.* Lord and Scott, Synops. Vert. Anim. Tas., 1924, p. 81, and fig. opp. p. 87, of a Tasmanian specimen. *Id.* McCulloch, Illustr. Austr. Encycl., i, 1925, p. 135, and fig. *Id.* Barnard, Ann. S. Afr. Mus., xxi, 1927, p. 788, pl. xxix, fig. 4. *Id.* Hughes, Proc. Roy. Soc. Vict. (n.s.), xli, 1, 1928, p. 49. San Remo, Victoria; trematode worm from gills. *Id.* Whitley, Rec. Austr. Mus., xvii, 1929, p. 119. *Id.* McCulloch, Austr. Mus. Mem., v, 1929, p. 268.

Scomber lanceolatus Cuvier and Valenciennes, Hist. Nat. Poiss., viii, "1831" = Jan., 1832, p. 204. *Ex* Forster, MS. Queen Charlotte Sound, N. Zealand. 20-23 dorsal spines. *Id.* Richardson, Trans. Zool. Soc. Lond., iii, 1, 1842, p. 120.

Thyrsites altivelis Richardson, Proc. Zool. Soc. Lond., vii, Nov., 1839, p. 99. Port Arthur, Tasmania. Type in British Museum. Seven dorsal and anal finlets. *Id.* Richardson, Tasm. Journ. Sci., i, 1842, pp. 99 and 108.

Thyrsites atten Richardson, Proc. Zool. Soc. Lond., vii, Nov., 1839, p. 99; Tasm. Journ. Sci., i, 1842, p. 108. Error for *T. atun*.

Thyrsites atun var. *altivelis* Richardson, Trans. Zool. Soc. Lond., iii (i), 1842, p. 119. Detailed description of Tasmanian specimen and comparison with *T. atun*.

Scomber splendens Richardson, Rept. 12th meet. Brit. Assn. Adv. Sci., 1842 (1843), p. 20. *Ex* Solander MS. Murderers' Bay, New Zealand.

Scomber dentex Richardson, Rept. 12th meet. Brit. Assn. Adv. Sci., 1842 (1843), p. 20. *Ex* Forster MS. Queen Charlotte Sound, New Zealand. Name preoccupied by *S. dentex* Bloch and Schneider, Syst. Ichth., 1801, p. 30. *Id.* Forster, Descr. Anim. (ed. Lichtenstein), 1844, p. 141. New Zealand. Equivalent to *Scomber dentatus* Bloch and Schneider, 1801, p. 24 (not *S. dentex*, p. 30).

Lucoscombrus atun van der Hoeven, Handbook of Zoology (trans. Clark), ii, 1858, p. 161 (Cape); see also Whitley, Rec. Austr. Mus., xvii, 1929, p. 119.

Leionura esox Bleeker, Nat. Tijdschr. Ned. Ind., xxi, 1860, p. 68. Name in synonymy *ex* Kuhl and van Hasselt MS. Type locality hereby designated South Africa, so as to make this name an absolute synonym of *Thyrsites atun* (Euphrasen).

Trichiurus atun Sauvage, Archiv. Zool. Exper., viii, 1879, p. 28. Error for *Thyrsites atun.*

Thersites atun McCoy, Prodr. Zool. Vict. dec. v, 1880, p. 19, pl. xliv, figs. 1, 1a-b (not 1c-d). Victoria. Six dorsal and anal finlets.

The foregoing represents an attempt to tabulate the synonymy and bibliography of the Barracouta, which is of considerable commercial value in Australia and New Zealand. This Barracouta, or 'couta, as it is generally termed, is quite different from the Barracuda of the West Indies, which is a Sphryrænoid fish. The South African Barracouta is known as Snoek whilst the Maori name for the New Zealand form is Manga. In South Australian waters, where barracouta are caught in poor condition, they are called "Axe-handles."

Apparently the genus *Thyrsites* is circum-Antarctic in distribution and is thus of considerable zoogeographical interest. The Australian Barracouta agrees well with the accounts of the typical *T. atun* from South Africa, but as the number of finlets and spines is sometimes more, should perhaps be distinguished as a subspecies, *T. atun altivelis* (Richardson). Several names are available for the New Zealand form and this, if distinct, will be named *T. atun dentatus* (Bloch and Schneider). The South American *T. chiliensis* Cuv. and Val. is not included in the above synonymy, although some authors have suggested its identity with *T. atun.*

The excellent figures given by Cuvier and Valenciennes, McCoy, and McCulloch render further illustrations superfluous at present.

The numbers of fin-spines, rays, and finlets, and the counts of vertebræ may be subject to constant variation in different regions and might well form the subject of statistical studies to determine racial limits in these fishes. So far, little has been done along these lines.

The Barracouta (*Thyrsites atun* formæ *dentatus* and *altivelis*) ranges from New Zealand to south-eastern Australia, where it is found from South Australia (mostly diseased specimens) to New South Wales (there is one record from Moreton Bay, Queensland). The species is evidently commonest in waters between south-eastern Tasmania and New Zealand, or in Victoria, but it seems that Tasmania or New Zealand would serve best as bases for its fishery. If the Australasian species be the same as the South African Snoek (*Thyrsites atun atun*), then this species also occurs in the waters of South Africa, Tristan d'Acunha, and St. Paul. The East Indian and Chilean forms of *Thyrsites* are doubtless distinct species; the former is apparently an unnamed species and the latter, *T. chiliensis* Cuv. and Val.

Mr. S. Fowler, Secretary of the Australian Fisheries Conference, Prime Minister's Department, Melbourne, remarks in a letter to me dated 11th August, 1930: "Because of their abundance and of the fact that the craft used for their capture is of the small, inshore type, Barracouta are necessarily taken from inshore waters, but I have been informed by fishermen that they have been caught in large quantities 20 miles south of Tasmania. To supply the present edible demand there is no need for fishermen to go far afield, but my own belief is that they exist in great quantities over a very wide area and at great distances from shore. I have a very high opinion of the potential economic value of these fish."

Family POMACENTRIDÆ.

Subfamily PARMINÆ.

Genus **Parma** Günther, 1862.

Parma unifasciata (Steindachner).

Pomacentrus unifasciatus Steindachner, Sitzb. Akad. Wiss. Wien, lvi, 1, 1867, p. 326, Port Jackson, New South Wales. Not *P. unifasciatus* Kner (Sitzb. Akad. Wiss. Wien, lviii, 1868, p. 31), from Fiji = *Pellochromis xanthosoma* (Bleeker). *Id.* Castelnau, Proc. Linn. Soc. N. S. Wales, iii, 1879, p. 354. *Id.* Ogilby, Cat. Fish. N. S. Wales, 1886, p. 43 (not synonymy). *Id.* McCulloch, Austr. Zool., ii, 3, 1922, p. 95, and Aust. Zool. Handbook, i, 1922, p. 69.

Parma unifasciatus Whitley, Mem. Qld. Mus., ix, 3, 1929, p. 243. *Id.* McCulloch, Austr. Mus. Mem., v, 2, 1929, p. 302.

D.xiii/18; A.ii/15; P.i/20; V.i/5; C.13. L.lat. 25 tubes + 8 punctured scales. L.tr.4/1/14.

Head (45 mm.) 3·14, depth (73) 1·9 and depth of caudal peduncle (22·5) 6·3 in length to hypural joint (142). Eye (10·5) 4·2, interorbital (17) 2·6 in head.

Profiles convex. Head higher than long and longer than broad. Eye rather small. Rugosities on the suborbital, supraorbital, and preorbital, and between the nostrils; others on the opercular flap and along the limb of the preoperculum, the latter tending to make the margin irregular and almost denticulate. Preorbital deeply notched anteriorly and forming a less noticeable notch where it meets the suborbital. Jaws subequal, with fleshy lips. A series of adjacent, compressed teeth in each jaw. Five branchiostegal rays, the lowermost small, the membranes broadly united across the isthmus. About eleven short, curved, pointed gill-rakers on lower limb of first gill-arch. Head scaly, except on snout, mouth, chin, throat and opercular margins. Top of head with numerous auxiliary scales. Nostril a simple opening half-way between eye and tip of snout.

Body ovate, robust, covered with broad, imbricate, ciliated scales, which extend on to the basal portions of all the fins except the ventrals. Lateral line rising obliquely to below the last dorsal spine, then curving steeply downward, its last tube below the median dorsal rays. Some caudal peduncle scales minutely punctured. About thirty transverse rows of body-scales between operculum and hypural joint.

Dorsal originating in advance of ventrals and pectorals and terminating behind anal; membranes of spinous portion with small pencils. Fifth and sixth spines longest, but not nearly so long as the longest (fifth and sixth) rays. Soft dorsal forming a high pointed lobe. Second anal spine shorter than most of the dorsal spines; the soft fin with a rounded margin. Pectorals shorter than head. Ventrals pointed, reaching beyond vent. Caudal lobes rounded, the upper considerably longer than the lower.

General colour, in alcohol, chocolate brown, darkest on the fins. A light brown patch on the posterior portion of the operculum. A light brown band extends from the bases of the eighth to tenth dorsal spines to the vent and anal origin and is broadest on the lower part of the sides. The caudal peduncle and posterior portion of the trunk are also light brown to a less extent, but no band is differentiated. Pale whitish spots underlie many of the body-scales. Snout and chin dark, breast and pectoral margin light in tone.

Described from a specimen 142 mm. in standard length or seven inches in total length. Australian Museum regd. no. IA.553.

Loc.—Washed up on Bondi Beach, near Sydney, New South Wales, after a storm, in January, 1922, and collected by Messrs. R. Hawkins and W. Barnes.

Two other specimens 125–146 mm. in standard length are in the Australian Museum from near Sydney. The smaller (IA.4880) was collected at Vaucluse, Port Jackson, by Mr. T. C. Roughley in March, 1931, and the larger (I.6848) at Maroubra by Mr. R. Rolleston some years ago. These agree with the specimen described above. The banded body and rugose snout and opercula are distinguishing features of this species, which seems to be commoner off the coast near Sydney than has hitherto been supposed.

Family LABRIDÆ.

Genus **Pseudolabrus** Bleeker, 1862.

Pseudolabrus cyprinaceus (White).

Labrus cyprinaceus White, Journ. Voy. New S. Wales, 1790, append., p. 264, pi. —, fig. 1. [Botany Bay or Port Jackson] New South Wales.

? *Labrus cyprinoides* Labillardière, Voy. rech. La Perouse, i, 1800, p. 419; *ibid.* (English translation), i, 1800, p. 472. Nomen nudum vel errore pro *L. cyprinaceus* White. 33° 55′ S. lat., 119° 32′ E. long.; several caught while vessel was at anchor.

Labrichthys gymnogenis Günther, Cat. Fish. Brit. Mus., iv, 1862, pp. 117 and 507. Australia. Type in British Museum.

Labrichthys nigromarginatus Macleay, Proc. Linn. Soc. N. S. Wales, iii, 1, Sept., 1878, p. 35, pl. iii, fig. 3. Port Jackson, New South Wales. Type in Macleay Museum, University of Sydney.

Pseudolabrus gymnogenis Roughley, Fish. Austr. Tech., 1916, p. 155, pl. liii; and of eastern Australian authors generally.

The name *Labrus cyprinaceus* White is evidently based on an old faded specimen of the Crimson-banded or White-spotted Parrot Fish of New South Wales, as the dark marks, radiating from the eye, as shown in White's figure, are often characteristic of this common and variable Sydney species. Thus White's name has priority over *Labrichthys gymnogenis* Günther and the fish should now be called *Pseudolabrus cyprinaceus* (White).

A Western Australian form of this species, apparently unnamed, perhaps formed the basis of Labillardière's *Labrus cyprinoides*; this name may best be disposed of by being regarded as a variant of *L. cyprinaceus* White.

Family GOBIIDÆ.

Genus **Lebetus** Winther, 1877.

Lebetus Winther, Naturhistorisk Tidsskrift Kjöbenhavn (3), xi, 1877, p. 49. Virtual haplotype, *Gobius scorpioides* Collett. *Id.* Smitt, Öfvers. K. Vetensk.-Akad. Förh., lvi, 1899, p. 554. *Ex* Winther. Cheek longer than postorbital part of head; male *G. scorpioides* = *G. orca* Collett. *Id.* Jordan, Gen. Fish., iii, 1919, p. 392. *Id.* F. de Buen, Trab. Inst. Esp. Oceanogr., v, 1930, pp. 5 and 21.

Lebistes Jordan, Gen. Fish., iv, Aug. 15, 1920, p. 487. Error for *Lebetus* Smitt. Orthotype, *L. scorpioides* Smitt = *Gobius scorpioides* Collett. Preoccupied by *Lebistes* Filippi, Arch. Zool. Anat. Fisiol., i, 1861–2, p. 69, another genus of fishes (*fide* Jordan, Gen. Fish., iii, 1919, p. 301; Classif. Fish., 1923, p. 158).

Butigobius Whitley, Austr. Zoologist, vi, 2, Jan. 14, 1930, p. 123. Orthotype, "*Lebistes scorpioides* Smitt" = error for *Gobius scorpioides* Collett.

Jordan (1920) quotes "**Lebistes** Smitt, 543; orthotype L. SCORPIOIDES Smitt. Not LEBISTES Filippi, 1862." His remarks on the [sub-] generic names in Smitt's 1899 paper are, however, rather misleading, as comparison with the copy in the Australian Museum library shows that wrong page numbers and other errors in quotation are made by Jordan. The new subgenera of *Gobius* proposed by Smitt, with their pages and types are:

Page 544. *Proterorhinus*. Haplotype, *Gobius marmoratus* Pallas [and vars.].

Page 545. *Eichwaldia*. Haplotype, *G. caspius* Eichwald [name preocc., replaced by *Eichwaldiella* Whitley, 1930].

Page 551. *Caffrogobius*. Orthotype, *G. nudiceps* [Cuv. and Val.].
Mapo. Haplotype, *Mapo soporator* (Cuv. and Val.) [including formæ].

Page 552. *Mugilogobius* [subgenus cælebs]; "from India and Japan." [Logotype, *Ctenogobius abei* Jordan and Snyder (*fide* Jordan).]

On page 554, Smitt gave the characters of "*Lebetus*, WINTHER.—*Gobius scorpioides*, COLL. (♂ = *Gob. orca*, COLL.)," and this is apparently the basis of Jordan's erroneous reference to *Lebistes* quoted above. Misled by the latter, and through not consulting Smitt's work, which was not available at the time, I proposed *Butigobius* in 1930 as a new name for "*Lebistes* Smitt," but my genus now becomes a synonym of *Lebetus* Winther, 1877.

My friend Mr. Anton Bruun, M.Sc., of Copenhagen, has very kindly furnished me with a copy of Winther's description of *Lebetus* and a translation into English of the same, as follows:

"The other one of the two species new to our fauna, *Gobius scorpioides* Collett, is here made a representative of a new genus. The separation of this species together with the nearly related *Gob. orca* (Collett) from *Gobius* Cuv. is based upon this peculiarity, that both species are lacking the main distinguishing character, the funnel-shaped fused ventrals, by which the genus *Gobius* from Cuvier's time has been sharply separated from the most nearly related Genera. *The ventrals in the two above mentioned species are indeed fused backwards, but forwards the hymen-like curtain, the anterior wall of the fin-funnel, is totally lacking;* furthermore, *the anterior dorsal fin is never triangular*, as in the true Gobies, but *quadrangular*, the membrane not continuing from the last dorsal ray backward down to the back; and the anal papilla seems to be lacking, but this last character is uncertain."

Order SCLEROPAREI.

Series **Platycephaliformes.**

The fishes vernacularly known as Flatheads are of much commercial importance in Australia, yet the major divisions into which they are classified have not been clearly defined and much work requires to be done before the various Australian species are satisfactorily known. As a preliminary step towards study, the following notes are offered.

Flatheads are mail-cheeked fishes, that is, they have the posterior projection of the suborbital bones across the cheek to the operculum, and are further distinguished by the depressed head, which is much broader than deep, and the wide gill-slits. The following is a key to the Australian families and subfamilies:

A. Body naked, with a row of large spiny bucklers along each side .... Family OPLICHTHYIDÆ.

AA. Body scaly, without large spiny bucklers on the sides .... Family PLATYCEPHALIDÆ.

B. Head moderately depressed, with strong ridges and spines.

C. Preopercle with a very strong antrorse spine on lower margin .... Subfamily ROGADIINÆ.

CC. Preopercle without an antrorse spine.

D. One enlarged spine on preopercular margin

E. Body deep. Fin-rays united by membrane along their length.

F. Sides of head unicarinate. Infraorbital ridge with close-set serrations. Orbit with cirrhus .... Subfamily ONIGOCIINÆ.

FF. Sides of head bicarinate Infraorbital ridge with spaced serrations. Orbit without cirrhus .... Subfamily INEGOCIINÆ.

EE. Body very shallow, elongate. Most of dorsal and anal rays united by membrane connected to their bases .... Subfamily ELATINÆ, *nov.*

DD Several small preopercular spines Head almost naked. Scales of lateral line enlarged and thickened .... Subfamily THYSANOPHRYINÆ, *nov.*

BB. Head greatly depressed, with feeble ridges and spines. Two enlarged spines on preopercular margin Head largely scaly No enlarged, thickened scales on lateral line. Vomerine teeth forming a curved band across vomer, not in two separate groups .... Subfamily PLATYCEPHALINÆ.

Subfamily PLATYCEPHALINÆ.

Genus **Trudis** Whitley, 1931.

Trudis Whitley, Austr. Zool., vi, 4, Feb. 13, 1931, p. 327. Orthotype, *Platycephalus bassensis* Cuvier and Valenciennes.

Median occipital ridges absent or rudimentary; no intermediate ridges between lateral occipital and supraorbital ridges.

Trudis bassensis (Cuvier and Valenciennes).

(Plate xxi, figs. 2–3.)

Platycephalus bassensis Cuvier and Valenciennes, Hist. Nat. Poiss., iv, Nov., 1829, p. 247. Westernport, Bass Strait (Quoy and Gaimard). Type in Paris Museum. *Id.* Quoy and Gaimard, Voy. Astrolabe, Zool., iii, 1835, p. 683, pl. x, fig. 3 (D'Entrecasteaux Channel, Tasmania). *Id.* Sauvage, Nouv. Arch. Mus. Hist. Nat. Paris (2), i, 1878, p. 150. Type re-described. *Id.* Waite, Rec. S. Austr. Mus., ii, 1, 1921, p. 173, fig. 282. *Id.* Hughes, Proc. Roy. Soc. Vict. (n.s.), xli, 1, 1928, p. 51 (Trematode parasite; Port Phillip, Victoria).

Platycephalus tasmanius Richardson, Trans. Zool. Soc Lond., iii, June 16, 1842, p. 96, and Zool. Voy., Erebus and Terror, Fish, 1845, p. 23, pl. xviii, figs. 1–2. Port Arthur, Tasmania. Types in British Museum.

Trudis bassensis Whitley, Austr. Zool., vi, 1931, p. 327.

The accompanying illustration shows one of three specimens, 8¼ to 9 inches long, from the Derwent River estuary, Tasmania. Austr. Mus. regd. nos. I.12794 to 12796. McCulloch (in MSS.) noted the colours of another specimen (no. E.4950) as "Cinder grey in colour with faint darker bands across the back. Entire head and body closely spotted with small reddish-brown spots, which are larger on the sides. Dorsals, pectorals and upper part of caudal also spotted, the latter with a black blotch on the lower half. Ventrals olive green. Lower parts whitish. Caught on line in about 8 fathoms close to Babel Island, Bass Strait."

Trudis cæruleopunctatus (McCulloch).

(Plate xxi, fig. 4.)

Platycephalus bassensis Tenison-Woods, Fish. Fisher. N. S. Wales, 1882, p. 67, and of New South Wales records generally. Not *P. bassensis* Cuvier and Valenciennes.

Platycephalus cæruleopunctatus McCulloch, Austr. Zool., ii, 3, 1922, p. 120; Austr. Zool. Handbook, i, 1922, p. 94. New name for *P. bassensis* of New South Wales authors, *non* Cuv. and Val. *Id.* Whitley, Austr. Zool., v, 4, 1929, p. 353.

D.viii/14; A.14; P.20; V.i/5, C.11. L.lat. 85 to root of caudal.

Head (88 mm.) nearly 3·3 in length from tip of snout to hypural joint (290). Eye (15·5) nearly 6·2, interorbital (11·5) 7·6, preorbital (20) 4·4 in length of head. Width of head between bases of preopercular spines 57 mm. Depth of head *circa* 19 mm. Cranial ridges prominent, smooth. A small antorbital spine, but no tentacles. Interorbital concave, its width slightly less than that of each eye. Eye-diameter greater than half its distance from end of mandible. Maxillary reaching to below anterior portion of pupil. Three preorbital spines, the posterior one very small. Bony stay of cheek smooth. Lower preopercular spine less than 1½ times length of upper. A broad band of villiform teeth in the upper jaw, becoming cardiform near the symphysis. A band of small teeth on the anterior portion of the lower jaw, which changes into a row of enlarged, curved teeth on the sides. Vomer with a patch of teeth, similar to those near the symphysis of the upper jaw, on each side. Palatines with a single series of enlarged teeth, having smaller teeth near their bases anteriorly. Gill-rakers short, pointed, pectinate; 14 on lower limit of first gill-arch.

Form elongate, depressed. Body covered with rather small ctenoid scales which extend over the head to before the eyes. Lateral line scales similar to the others, but each with a broad, rather flattened tube.

Base of second dorsal fin shorter than that of anal. First dorsal originating a little in advance of ventrals. Pectorals little shorter than postorbital portion of head. Ventrals long, equal to head without snout, and reaching beyond the vent. Caudal rounded.

Colour, after long preservation in alcohol, brownish. Some blackish marks on the distal parts of the membranes of the caudal fin, and crossing the ends of the lower caudal rays.

Described from the lectotype of *Platycephalus cæruleopunctatus* McCulloch, a specimen, thirteen inches long, dredged in Port Jackson by J. D. Ogilby. Austr. Mus. regd. no. I.3163. Figured from a similar specimen (no. I.10110) caught at Watson's Bay, near Sydney, by H. Coleman and E. le G. Troughton.

Genus Longitrudis Whitley, 1931.

Longitrudis Whitley, Austr. Zool., vi, 4, Feb. 13, 1931, p. 327. Orthotype, *Platycephalus longispinis* Macleay.

A short median occipital ridge present; lateral occipital ridges connected with the supraorbital ridges by intermediate ones.

Longitrudis longispinis (Macleay).

(Plate xxi, fig. 1.)

Platycephalus longispinis Macleay, Proc. Linn. Soc. N. S. Wales, ix, 1, May 23, 1884, p. 170. Outside Port Jackson, N. S. Wales; 50 faths. *Id.* Stead, Fish. Austr., 1906, pp. 197 and 265, and Edib. Fish. N. S. Wales, 1908, p. 112. *Id.* McCulloch, Austr. Zool., ii, 3, 1922, p. 121.

Longitrudis longispinis Whitley, Austr. Zool., vi, 4, 1931, p. 327.

Here figured from an example $10\frac{5}{8}$ inches in total length, with 38 transverse series of body-scales, from near Sydney, New South Wales. Austr. Mus. regd. no. I.9569. Presented by the State Fisheries Department in 1908.

Genus **Neoplatycephalus** Castelnau, 1872.

Neoplatycephalus Castelnau, Proc. Zool. Acclim. Soc. Vict., i, July 15, 1872, p. 87. Haplotype, *N. grandis* Castelnau.

Easily recognized by its long canine teeth.

Neoplatycephalus macrodon (Ogilby).

(Plate xxi, figs. 5–6.)

Platycephalus macrodon Ogilby, Abstr. Proc. Linn. Soc. N. S. Wales, May 27, 1885, p. iv, *nomen nudum*, and Proc. Linn. Soc. N. S. Wales, x, 2, July 31, 1885, pp. 189 and 226. Port Jackson, N. S. Wales. Type in Austr. Mus. *Id.* Waite and McCulloch, Trans. Roy. Soc. S. Austr., xxxix, 1915, p. 468, pl. xii, fig. 4, as *N. macrodon* (gill-arch).

Platycephalus sp., Stead, Edib. Fish. N. S. Wales, 1908, p. 113.

Platycephalus (*Neoplatycephalus*) *macrodon* McCulloch, Austr. Zool., ii, 3, 1922, p. 121.

Neoplatycephalus macrodon Roughley, Fish. Austr. Tech., 1916, p. 183.

D.viii/14; A.14; P.20; V.i/5; C. 12; L.lat. less than 70 to root of caudal.

Head (95 mm.) 2·9 in length from tip of snout to hypural joint (282). Eye (18) 5·2, interorbital (13) 7·3, preorbital (maximum 22 mm.) 4·3 in length of head. Width of head between bases of preopercular spines 56 mm. Depth of head *circa* 28 mm.

Cranial ridges low, smooth. A small antorbital spine, but no ocular tentacles. Interorbital flat, sunken, its width subequal to that of each eye. Maxillary reaching to below anterior portion of pupil. Two preorbital spines and a tiny projection suggesting a vestigial third; the first spine is twice as long and strong as the second. Bony stay of cheek smooth. Preopercular spines strong, the lower slightly longer than the upper. A band of villiform teeth in the upper jaw with a few canines, the hindmost ones largest, near the symphysis. Lower jaw with a row of canines at each side, with some villiform teeth behind the few canines near the symphysis. Vomer with a curved band of small, pointed teeth. Four or five large canines and a row of villiform teeth on each palatine. 11 or 12 gill-rakers on lower limit of first gill-arch, arranged in pairs and becoming rudimentary anteriorly.

Form elongate, fairly robust. Body covered with moderate, weakly ctenoid scales which extend over the head to the cheeks and upper parts of the snout.

First dorsal fin originating in advance of ventrals. Base of second dorsal slightly shorter than that of anal. Pectorals nearly equal in length to postorbital portion of head. Ventrals equal to distance from first dorsal spine to first dorsal ray. Caudal subtruncate.

Colour, after long preservation in alcohol, brown with a dark mark on each operculum and the end of the caudal fuscous.

Described and figured from the holotype of *Platycephalus macrodon* Ogilby, a specimen a little over thirteen inches long, dredged by Mr. J. D. Ogilby in Port Jackson over forty years ago. Austr. Mus. regd. no. B.6541.

This species grows to a length of over twenty-one inches and is forming the subject of detailed investigations as to growth-rate, age, etc., by members of the Department of Zoology, University of Sydney.

EXPLANATIONS OF PLATES.

PLATE XX.

Fig. 1.—*Isuropsis* sp. Lateral view of an immature female specimen from South Africa.

Fig. 2.—*Isuropsis* sp. Ventral view of the same specimen.

Fig. 3.—*Notorynchus macdonaldi* Whitley. Female holotype from Manly, New South Wales.

Fig. 4.—*Notorynchus macdonaldi* Whitley. Snout and jaws of the same specimen.

Fig. 5.—*Notorynchus macdonaldi* Whitley. Dorsal view of head and anterior part of body to show colour-markings.

PLATE XXI.

Fig. 1.—*Longitrudis longispinis* (Macleay). A specimen from near Sydney, New South Wales.

Fig. 2.—*Trudis bassensis* (Cuvier and Valenciennes). A specimen from the Derwent River estuary, Tasmania.

Fig. 3.—*Trudis bassensis* (Cuvier and Valenciennes). Dorsal view of head of same specimen.

Fig. 4.—*Trudis cœruleopunctatus* (McCulloch) A specimen from Watson's Bay, near Sydney, New South Wales.

Fig. 5.—*Neoplatycephalus macrodon* (Ogilby). Lateral view of holotype from Port Jackson, New South Wales.

Fig. 6.—*Neoplatycephalus macrodon* (Ogilby). Dorsal view of holotype.

TWO NEW SPECIES OF THE GENUS *NOTOSCOLEX* (OLIGOCHÆTA) FROM ULLADULLA, NEW SOUTH WALES.

By

W. Boardman,

Assistant Zoologist, The Australian Museum.

(Figures 1-6.)

The two new species described below were collected by the author from the bank of a small creek at Ulladulla, south coast of New South Wales, on 9th December, 1928.

Genus Notoscolex Fletcher, 1886.

Notoscolex ulladullæ, sp. nov.

(Figures 1-3.)

External Characters.

Length 160 mm.; diameter 3 mm. Colour in alcohol yellowish grey. Segments about 185 but posterior end regenerated; commencing about midbody and continuing to the posterior end the segments are triannular. On the ventral surface there is a longitudinal, shallow, flat-bottomed groove extending from xix to xxv; the edges of the groove follow line of setæ *b* and the flat bottom lies on *aa*.

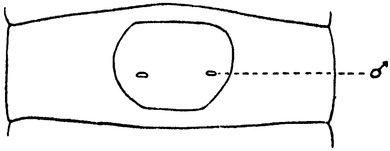
Prostomium combined pro- and tanylobous.

Dorsal pores commence in furrow 7/8.

Setæ widely paired. In front of the clitellum $ab = \frac{2}{3}aa = \frac{3}{5}bc = \frac{6}{13}cd$ (or $ab:aa:bc:cd = 6:9:10:13$); behind the clitellum $ab = \frac{8}{15}aa = \frac{3}{5}bc = \frac{12}{25}cd$ (or $ab:aa:bc:cd = 4\frac{4}{5}:9:8:10$); at midbody $ab = <\frac{1}{2}aa = \frac{10}{17}bc = \frac{1}{2}cd$ (or $ab:aa:bc:cd = 5:10\frac{2}{3}:8\frac{1}{2}:10$); *dd* is less than half the circumference. The lines of setæ *a* and *b* converge towards the male pores.

The clitellum extends from ⅔xiv–⅓xxii (= 8) but is not strongly developed and has the boundaries poorly defined; setæ (except *a* and *b* on xviii) and dorsal pores present.

The ventral surface of segment xviii has its anterior boundary curved outwards a little making it larger than its neighbours. The male field is in the form of a glandular patch having its anterior and posterior boundaries parallel with, and well clear of, the intersegmental furrows; nearer the anterior than the posterior furrow. The posterior edge of the field is only a little more than half the length of the anterior; the lateral boundaries are curved and the corners of the figure so formed rounded. The field extends to half-way between *a* and *b* on each side. The male pores are paired and are situated on the field in line with the setæ ring and just ventral of *a*.



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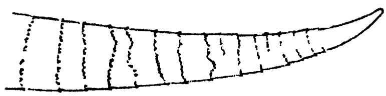

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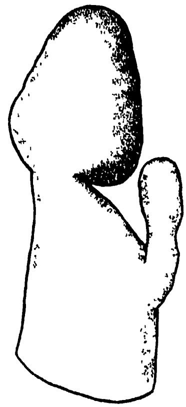

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FIGURES 1-3.—*Notoscolex ulladullæ*, sp. nov.
1. Male genital area. 2. Distal end of a penial seta showing portion of ornamentation as seen under microscope × ca. 350 diameters. 3. Spermatheca, from paratype, × 34.

The female pores are paired on xiv, about in line with *a* and just anterior to the setæ ring.

The spermathecal pores are two pairs placed at the anterior edge of viii and ix and are slightly ventral to *a*.

Copulatory cushions are present on xii, xiii, xv, xvi, xvii, xix, xx and xxi all with the transverse axis anterior of the setæ ring. The cushion on xii is small and oval, lies anterior to the setæ ring and extends across the segment for $\frac{5}{7}$ of *aa*; that on xiii is also oval and similarly placed, but larger, extending almost to *a* on each side. Those on xv and xvi tend to be circular, particularly the one on xvi; both extend not quite to *a*. The one on xvii is similarly placed, almost circular and also extends almost to *a*. The cushions on xix and xxi tend to be circular but that on xx is semicircular in outline with the flattened edge anterior; all three extend not quite to *a*.

Internal Anatomy.

Septa 5/6–12/13 thickened, of which 6/7–9/10 are muscular and stout and about the same thickness; 10/11–12/13 progressively thinner and 5/6 about the same as 10/11.

Gizzard in vi, large and muscular.

Calciferous glands are three pairs in xiv–xvi, adjoin above the intestine. Large intestine commences in xviii.

Last heart in xii.

The excretory system is micronephric, the micronephridia being scattered; a meganephridium on each side in the hindermost segments. The scattered micronephridia are fewest in xi, xii, and xiii, the few present attached to the anterior face of the septa. In front of xi the nephridia are more numerous and mostly attached to the ventral portion of the anterior face of the septa; particularly

numerous in v and vi. Attached to the posterior face of septum 4/5 there is a pair of compact, lightly coloured bodies which are probably peptonephridial tufts.

Testes and funnels paired and free in x and xi. Seminal vesicles two pairs in ix and xii, small. The anterior ones are the smaller and are placed low down on the anterior face of the septum; the posterior pair are placed higher up on the posterior face of the septum.

Prostates paired in xviii; the one on the right side broad and leaf-shaped, that on the left considerably narrower and thicker; both lobed slightly. The duct short, straight, shiny and in length less than one-third the length of the gland. I could not ascertain where the vas deferens joins the prostatic duct.

The penial setæ sacs are three times as long as the prostatic duct and unite with the duct at the body wall; two fully developed setæ present in the sacs. The figured penial seta is about 3·2 mm. long with a diameter of 21 μ at the middle and 24 μ at the proximal end. The shaft is curved and rather sharply pointed. Except at the extreme point the tip is ornamented with transverse, somewhat irregular rows of triangular teeth; the majority of the rows seem to form complete rings but a few only partially extend round the shaft.

Ovaries paired and with funnels in xiii.

The spermathecæ are two pairs in viii and ix. The duct is short and thick, being about twice as long as broad (considerably thicker in the figured example from a paratype, *viz.*, one and a half times as long as broad), and terminates in a pear-shaped ampulla; the ampulla is broader at the base where the duct runs into it and tapers to a blunt extremity. At the point of union of the duct and the ampulla the duct is slightly constricted. There is a single diverticulum, small and club-shaped, attached by a short stalk at a point on the main duct about half of its length along from the body wall.

Holotype in Australian Museum collection, registration no. W.2836.

Variation.

In addition to the holotype there are eight immature paratypes, the smallest of which is 106 mm. and the largest 159 mm. long; the number of segments varies from 158 to 217. Four of the paratypes have an additional copulatory cushion on xxii similar to the one immediately preceding it. Of these four one has no cushion on xvii and the epidermis glandular round setæ *a* on xix and to a lesser extent on xx, the edges of the areas so formed coalesced with the copulatory cushion between; one has the cushion on xvii very weakly developed and in another the cushion on xvii is also very weakly developed and no cushion on xii. One specimen has no cushion on either xxi or xxii.

Paratypes in Australian Museum collection, registration nos. W.2837-39.

Notoscolex attenuatus, sp. nov.

(Figures 4–6.)

External Characters.

Length 310 mm.; diameter 3 to 3·5 mm. behind the clitellum. Colour in alcohol a deep cream, here and there tinged with green. Segments 304; ix to xvi faintly triannular, vii and viii have only the second annular ring developed; behind the anterior third of the body annulation again commences, usually two distinct and three fainter alternating annular rings being present; the posterior quarter triannulate.

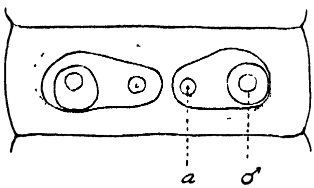
Prostomium tanylobous, tongue cut off behind.

Dorsal pores begin in furrow 7/8.

Setae paired in regular lines. In front of the clitellum $ab = \frac{1}{3}aa = \frac{1}{2}bc = \frac{2}{3}cd$ (or $ab:aa:bc:cd$ = 7:22:13:10); behind the clitellum $ab = >\frac{1}{5}aa = \frac{1}{3}bc = \frac{1}{2}cd$ (or $ab:aa:bc:cd$ = 4:19:11:9); the midbody reading is $ab = \frac{1}{3}aa = \frac{1}{2}bc = \frac{5}{7}cd$ (or $ab:aa:bc:cd$ = 5:15:9:7); *dd* is greater than half the circumference.

The clitellum is not well developed and the limits are not clearly defined; it seems to extend from ½xiii–xviii (= 5½) and possibly includes a small portion of xix as well. Setæ present.

The male field on xviii is mainly made up of two lateral, somewhat oval, glandular patches each extending from near the midventral line to just beyond *b* and almost as deep as the segment; they are well clear of the intersegmental furrows of which they are nearer the anterior than the posterior. The patches are connected by a glandular band of slightly greater depth, the anterior and posterior edges curved inwards a little. The male pores have tumid lips and are placed laterally and at the posterior edge of the glandular patches; they have a diameter almost equal to, and lie within *ab*. On or very near the inner edge of each patch and forming a bulge in its outline there is a well defined pore probably associated with a gland.



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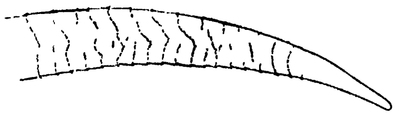

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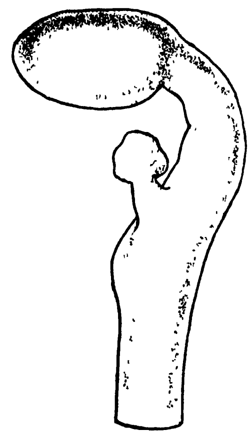

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FIGURES 4-6.—*Notoscolex attenuatus*, sp. nov.
4. Male genital field; *a*, gland pores. 5. Distal end of a penial seta showing portion of ornamentation as seen under microscope × ca. 300 diameters. 6. Spermatheca, from paratype, × 14.

The female pores are paired and close together on xiv and slightly anterior of the setæ ring.

The spermathecal pores are two pairs placed at the anterior edge of viii and ix in furrows 7/8 and 8/9 respectively and just dorsal of *a*.

There are copulatory cushions on xi, xv, xvi, and xvii. On xvii the cushion is in the form of a transversely placed, elongate area shaped like a dumb-bell which lies along and just includes *aa*, its longitudinal axis anterior to the setæ

ring; especially on the anterior and posterior edges bordered by a lighter coloured glandular area giving the whole a somewhat oval outline. In a line along the axis of the portion shaped like a dumb-bell there are four pores approximately equidistant from each other and similar to those on the male field referred to as being presumably associated with a gland. On xvi there is a similar area extending not quite to *a* and also having four pores on the transverse axis, the left pair being fused. That on xv is not quite so large, extends nearly to *a* on each side, and has four pores of which the left two are also fused. The cushion on xi lies within *aa*, is not so well developed as those further back, being composed of three small, more or less circular glandular areas the edges of adjacent ones fused; each area bears a pore. In addition there is on xix a pair of roughly oval flattened papillæ placed immediately dorsal and anterior to *a*, extending laterally beyond *b* for a distance slightly greater than *ab* and forward to the anterior border of the segment; on each immediately lateral to *b* there is a pore similar to those on the other glandular patches and between the two papillæ is a narrower, connecting, less well developed glandular band lying along the setæ ring.

Internal Anatomy.

Septum 6/7 slightly thickened, 7/8 and 8/9 progressively thicker, 9/10–12/13 stout and firm, 13/14 slightly thickened.

The gizzard in vi is well developed and barrel-shaped with its anterior end somewhat invaginated.

Calciferous glands are three pairs in xiv–xvi attached by a broad base to the intestine. The large intestine commences in xviii.

The last heart is in xii.

The excretory system is micronephric with a meganephridium on each side in the hindermost segments. Behind xii micronephridia plentifully scattered over the walls of the segments, in viii–xii rather sparsely scattered particularly in viii and ix; micronephridia on anterior face of several of the septa of the pre-clitellar region. Bushy tufts of peptonephridia present attached to the hinder portion of the pharynx.

Testes and funnels free in x and xi. Seminal vesicles two pairs, in xi and xii, grape-like, attached to the posterior face of 10/11 and 11/12 respectively; adjoin above the intestine.

Prostates lobed and paired in xviii with short, straight muscular duct. The vas deferens enters the prostatic duct at a point about $\frac{2}{3}$ along from its proximal end.

The penial setæ sacs, each of which seems to contain four penial setæ, are about twice as long as the prostatic duct and enter the duct at the body wall.

The figured example is about 3·2 mm. long; the diameter at the middle is 50 μ and at the proximal end of the curved portion about 55 μ. From just above a short, swollen, proximal end the shaft is curved slightly, the curve at the tip accentuated a little; the tip is bluntly pointed. Except at the extreme point the tip is ornamented with irregular rows of small triangular teeth. The general tendency of the longer rows (particularly those greater than the semi-circumference) is to be placed obliquely. At the proximal portion of the ornamented region the rows become more widely separated before finally ceasing.

The spermathecæ are two pairs in viii and ix. The ampulla is large and spherical, having a diameter equal to about half the length of the duct; there is a general tapering of the duct towards the ampulla, but from the body wall to a point about one-third along the duct one side diverges and then forms a shoulder and from near the concavity so formed there arises a small almost spherical diverticulum attached by a short stalk to the main duct.

Holotype and mounts in Australian Museum collection, registration nos. W.2823-25.

Variation.

In addition to the holotype there are thirteen paratypes, of which six have the clitellum developed. The paratypes range from 190–270 mm. in length and the number of segments from 204–273 in the mature examples. In two specimens the dorsal pores commence in groove 6/7 and not 7/8 as in the holotype.

The setæ formulæ of the paratypes show that *ab*:*aa* varies considerably since *ab* may equal $>\frac{1}{3}-\frac{1}{2}$ *aa*; what variation exists in *bc*:*cd* tends towards making *bc* and *cd* more nearly the same, but when not equal *bc* is almost invariably the greater. The clitellum is distinctly marked in some of the paratypes and includes segments xiv–xviii, generally plus a small portion of xiii and xix ($= 5\frac{1}{n}$); it is saddle-shaped and extends as far ventrally as *b*.

The oval glandular patches which carry the male pores sometimes have the bulge caused by the gland pore projecting so far ventrally as to cause the ventral edges of the bulges to unite. The female pores are sometimes in a shallow, narrow, oval depression.

In addition to the copulatory cushions on xi, xv, xvi, and xvii most of the paratypes have a similar one on xii and one specimen has that on xi absent but one on xii; rarely specimens with cushions on xi and xii have one or the other extending to *b* on each side. A small papilla midventrally placed on x occurs on one specimen and another has an oval cushion on the same segment placed on the left side and extending from *a* to a short distance across the midventral line. The cushion on xv is sometimes only weakly developed. The number of gland pores on the cushions varies from 2–4; in one specimen there are three on each of the flattened papillæ on xix and in another on the glandular band between these papillæ there is an additional pair.

Paratypes in Australian Museum collection, registration nos. W.2826-35.

* * * * * *

Affinities.—The two species *Notoscolex ulladullæ* and *N. attenuatus* seem to be more closely related to each other than to other members of the genus. Although easily separable the general anatomy of the two species, especially the arrangement of the nephridia, the form of the spermathecæ and the ornamentation of the penial setæ, suggests a decided relationship.

THE EVOLUTION OF THE ANAMNIOTA.

By

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Contents.

"Since the days when Gegenbauer and Thatcher and Balfour propounded their views on the origin of the limbs, vertebrate morphology has not been standing still. Great increases have been made in our knowledge. Now, in considering the working hypotheses of these earlier days of morphology, we should remember that increase in our knowledge may greatly alter our point of view, and it seems in my humble opinion that it is conducive to progress, not so much to search for new detailed facts which may bolster one or other of existing hypotheses, as to endeavour to make an impartial survey of the facts as we know them and then to consider carefully whether the body of facts so surveyed seems to suggest a working hypothesis drawn up on the original lines or one drawn up on somewhat different lines."[1]

Thus, without asking his permission, I call upon Professor Graham Kerr to provide an introduction to a paper on speculative morphology.

That which follows is an attempt to harmonize the facts of development and adult anatomy of the Anamniota. In no case, I am well aware, would I be justified in writing Q.E.D. at the end of any section or argument. Basing conclusions on unavoidably scanty circumstantial evidence, the student of evolution who adopts a dogmatic attitude or positive language, such as that italicized by Professor Kerr at the foot of page 278, betrays an unphilosophic mind or a partisan conviction. None of our working hypotheses can be proven, they are but statements of probabilities, and, as such, then, the conclusions arrived at herein are presented.

My conclusions are embodied in the diagram below, so that in it I present, as it were, a thesis which it is intended to defend in the following pages. The two most radical conclusions which it is intended to convey by the diagram are:

1. The Chondrostei are bony Elasmobranchs.
2. The Dipnoi are primitive amphibians.

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[1] Kerr.—*In* The Work of J. S. Budgett, 4to., Cambridge, 1907, pp. 277-8.

This work is founded on the study of a fairly wide range of material which includes the following: (1) a very fine series of teleostean specimens, placed at my disposal by Dr. C. Anderson, Director of the Australian Museum; (2) *Chimæra* and *Tandanus*, received from the New South Wales Fisheries Department; (3) *Callorhynchus antarcticus*, from the Hon. G. H. Thomson of Dunedin, New Zealand; (4) *Amia*, *Lepidosteus*, and *Acipenser*, as well as *Necturus*, *Pseudotriton*, *Notophthalmus* and *Amblystoma*, through Professor W. K. Gregory, from the American Museum of Natural History; (5) a large number of *Amblystoma tigrinum* in alcohol and several beautiful series of sections of the head of *Amphiuma*, from Professors C. Judson Herrick and H. W. Norris; (6) *Neoceratodus*, from Dr. T. Bancroft, Eidsvold, Queensland; (7) *Psephurus*, from Mr. A. De C. Sowerby, Shanghai, China; (8) *Lepidosiren*, through Mr. Carl P. Schmidt, from the Field Museum of Natural History, Chicago; (9) various anurous amphibians and a number of elasmobranchs collected by myself and my friends.

I have to acknowledge my indebtedness to the gentlemen and institutions mentioned above and to thank them for their assistance.

From this list it will be gathered that I have not been able to dissect for myself either of the recent crossopterygians, or *Protopterus*, and that I have also had to rely entirely on the work of others for my knowledge of the anatomy of the gymnophiones; for the rest I have been able to study at first hand the structures of representatives of all the forms discussed.[2]

The embryological material has not been so varied: (1) sections of the head of embryonic Trout and *Sparus*; the lengths of these were not known, but they were all stages prior to the formation of bone; (2) longitudinal sections of the head, 8 mm. in length, of an unidentified shark, and well advanced as to the

[2] Since this paper was finished Professor H. W. Norris placed me further in his debt by presenting me with several very fine sets of transverse sections of gymnophione heads, and I received a skull of *Polypterus* from Ward's Natural Science Establishment, Rochester, New York. I have also had the opportunity of working out very completely the development of the chondrocranium of the lizard *Physignathus lesueurii*, Gray, and that of the common fowl, as well as one stage in the development of the chondrocranium of the Frogmouth, *Podargus*.

EXPLANATION OF THE DIAGRAM.

Pregnathostomes.—The salient features of these are briefly reviewed in the text.

Archignathostomes.—Protovertebrata which have the first visceral arch essentially similar to the rest of the arches, but functioning at times as a jaw. The foregut has a dorsally situated glandular caecum.

Neognathostomes, or *Astylic Gnathostomes.*—The first arch is definitely modified to act as a jaw, but is held in place, fore and aft, by fibrous unions only.

Archistylica.—Gnathostomes in which the maxillary arch is in cartilaginous union with the trabecula anteriorly, in the ethmoid region; probably a feature of many Pre- and Protopulmonates.

Prepulmonates.—Archistylic Gnathostomes in which, it is assumed, the dorsal glandular caecum of the foregut is large and flaccid.

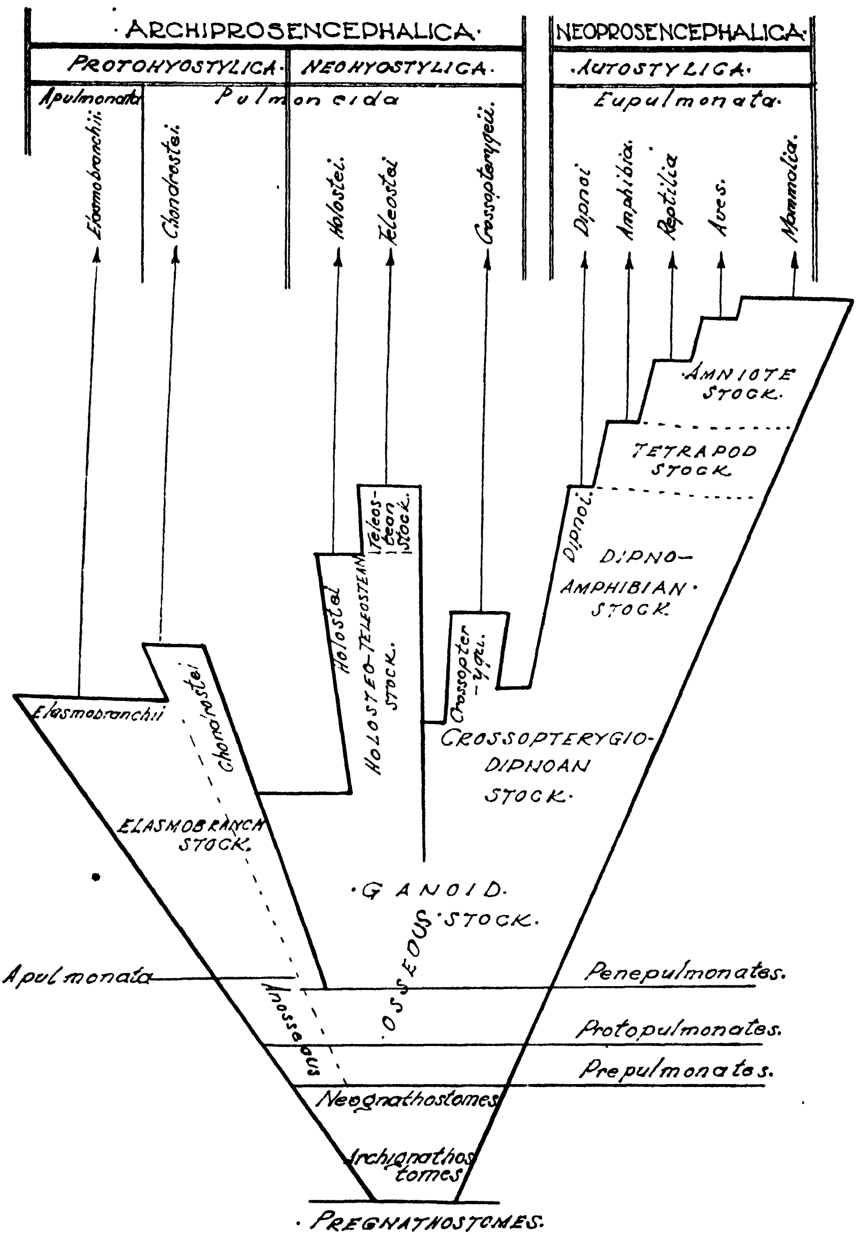
Protopulmonates.—In this stage of the evolution of the lung, it is assumed that the dorsal caecum now contains gases, but has as yet no function to perform relevant thereto.

Penepulmonates.—It is assumed that now the "almost-lung" has gained control of its gaseous contents by muscular and/or glandular activity.

Apulmonata.—It is assumed that the caecum has become aborted.

Pulmoneida.—Greek: eidos – like.

The terms used at the top of the diagram are fully discussed in the text.



For explanation see foot of preceding page.

chondrocranial structures; (3) complete sets of embryos of *Hyla aurea*, *Hyla cœrulea* and *Lymnodynastes peronii* from the deposition of the eggs up to the appearance of the forelimbs, collected, a few each day. From these latter I have prepared sections which enable me to state that the phenomena of development of the chondrocranium is so closely similar to that described by Parker and Gaupp in *Rana* that I do not deem it useful to publish any further account of my findings.

Though this embryological material is scanty, its study has enabled me to understand embryological literature and drawings as I should not have done without it.

The Elasmobranch Age.

1. *The Pregnathostomes.*

Before we discuss the evolution of the fishes and amphibians it is desirable that we attempt to form some idea of the structure of the early vertebrates, pregnathostomes, from which they have evolved. We have been taught to believe that in its development each animal "climbs its own genealogical tree," and there is little reason to doubt that we have been taught aright. Now, if in our studies of embryology we find certain structural features appearing in all the vertebrates, then, even if these features be evanescent in some forms, we feel justified in concluding that the features in question were present in the common ancestor of all the forms studied.

Not only is this so, but, remembering that the adult is but the last stage in the life history, we are equally justified in assuming that structures possessed by adult forms in common were also inherited.

Two striking illustrations. Because all vertebrates *are* vertebrate, we assume a vertebrate ancestor. Because all amniotes have an amnion, we assume an amniotic ancestor for the group, distinct and different from that of the Anamniota, though, as just pointed out, tracing their ancestry further back we find that they have both sprung from a common stock.

It is believed that if we sift carefully the evidence provided by the life histories and adult anatomies of the Anamniota we shall be able to arrive at the probable structure of the various ancestors as we trace backwards the converging lines of similitude.

Before proceeding to an analysis of the life histories it will not be out of place to enumerate those structural features which we are all agreed must have been present in the ancestral vertebrate stock.

The Archi- or Protovertebrata, pregnathostomes, were provided with a segmented nervous system, whose central stem was enclosed in a more or less continuous vertebral column. The anterior end of this system had become enlarged, in consonance with the importance of certain organs of special sense, eyes, olfactory organs, the organs of equilibration, and probably tactile organs. Respiration was effected by a series of gills, which were related to clefts in the body wall anteriorly; these clefts opened into the fore end of the gut. The gill clefts were supported by skeletal arches, and in relation to these and their respiratory function a system of muscles had been developed, whereby the clefts

could be opened and closed. Herein was an added cause for the increased complexity of the anterior end of the nerve stem, to which was also added certain oculomotor nerves. There was a well developed blood vascular system with the motor power restricted to a short segment of the main vessel, a primitive heart. The intestine was slightly, if at all, convoluted, it was provided with a definite set of muscles whereby the anterior orifice was enabled to function as a mouth, under voluntary control, and a sphincter ani, which probably acted entirely reflexly. Hepatic and pancreatic glandular tissues were present and poured their products into the gut. A cœlomic cavity was well developed. The excretory system was a pronephros composed of coiled tubulo-glandular tissue; it probably emptied into the hind gut. Only one gonad, male or female, was present.

It is further agreed that the body was fish-like, and that its muscles were arranged metamerically, and also that the anterior end of the nerve stem was enclosed in a cartilaginous capsule, the chondrocranium, which had built into it the capsules for the organs of special sense, and was more or less continuous with the vertebral column.

It is also agreed that dorsal and ventral fins were present, and in all probability paired anterior and posterior fins.

These, then, are the generally conceded attributes of the archi-vertebrata. Our problem is to discover by what modifications the various fishes and the amphibia were evolved, and how these are related one to another and to the ancient stock from which they have evolved.

2. *The Evolution of the Jaws.*

That I begin with certain cranial structures is not because I regard them as of pre-eminent importance, but because I am more familiar with cranial structures than with any others.

Since the review of the phylogeny of the Dipneusta by Dollo[3] and of their anatomy, development and classification by Bridge,[4] our knowledge of their embryology has been increased by Agar[5] and Kerr[6] and by several contributions of a comparative nature from Edgeworth during the years 1911 and 1926, which are of especial value. Kellicott[7] has given us a very valuable paper on the development of the respiratory and vascular systems of *Neoceratodus*.

In the five tables which follow, the facts in connection with the development of the palato-pterygo-quadrate arch have been collected. Two of these tables are taken direct from Edgeworth,[8] the others are largely compiled from his work. In the tables of my own compilation I have added a column giving the authority for the fact recorded. In some of these cases I have with confidence accepted the fact and authority from Edgeworth without troubling to confirm it.

[3] Dollo.—Bull. Soc. Belge Geol. Pal., ix, 1895, pp. 79-128.
[4] Bridge.—*In* Cambridge Natural History, vii, Fishes, 8vo., London, 1904.
[5] Agar.—Trans. Roy. Soc. Edin., xlv, 1906, pp. 49-54.
[6] Kerr.—Quart. Journ. Micro. Sci., xlvi, pp. 417-459.
[7] Kellicott.—Mem. N.Y. Acad. Sci., ii, 4, 1905, pp. 185-249.
[8] Edgeworth.—Journ. Anat., lix, 1925, pp. 225-264.

TABLE I.

The palato-quadrate cartilage first appears

In	As an independent cartilage not attached at any point to the neural cranium.	Attached to the trabecula or ethmoid plate.	Authority.
Petromyzon		+[9]	Parker
Scyllium	+		Edgeworth
Heterodontus	+		,,
Acipenser	+		Parker
Polypterus	+		Budgett
Amia			Swinnerton
Lepidosteus		+[10]	Parker
Gymnarchus	+		Assheton
Gasterosteus	+		Swinnerton
Belone	+		,,
Zoarcia	+		,,
Salmo	+		Winslow
Neoceratodus	+		Edgeworth
Lepidosiren		+[9]	Agar
Protopterus		+[9]	Agar[11]
Ichthyophis	+		Peters
Menopoma	+		Edgeworth
Siren	+		Gaupp
Triton	+		Edgeworth
Hyla	+?		Kesteven
Limnodynastes	+		,,
Rana	+		Gaupp
Amblystoma	+?		Edgeworth
Salamandra	+?		,,
Plethodon	+?		,,
Spelerpes	+?		,,
Hynobius	+?		,,
Megalobatrachus	+?		,,
Salamandrella	+?		,,
Ranodon	+?		,,
Amphiuma	+?		Winslow
Necturus	+?		Platt
Desmognathus	+?		Wiedersheim

In the case of the forms marked "?" the youngest stages studied have had one or two attachments between the neural cranium and the palato-quadrate, but, inasmuch as that in several amphibians an originally free palato-quadrate has been observed to become attached by one, two, and three processes successively, one is justified in assuming that, had earlier stages been studied in these other cases, they also would have been found to have the palato-quadrate entirely free at its first appearance.

TABLE II.

The order in time of attachment of the Quadrate, in dipnoans and amphibians, to the cranium by ascending otic, and basal processes.

It is not claimed for this table that it conveys a final statement of the facts set out; on the contrary it is believed that, with more complete series of early embryos, most, if not all of the forms, would be found to gain attachment to the cranium by the three processes in succession. The table presents the present state of our knowledge, as far as I have been able to abstract the literature. The order of sequence of attachment is indicated by the numerals; where the same numeral appears in two or more

[9] In these cases the palato-quadrate bar first appears as a spur or lateral process of the hinder end of the trabecula.

[10] In this form the palato-quadrate is attached *ab initio* to the lateral cornu of the ethmoid.

[11] Several other fishes might have been included in the table, but every case known in which the bar is not originally quite free has been, I believe, included in the table.

columns, it simply means that, in the youngest stage I have found an account of, two or more attachments were already established.

Forms.	Ascending process.	Otic process.	Basal process.	Authority.
Neoceratodus				
Protopterus	?	?	1	Agar[12]
Lepidosiren	2	1	2?	Agar[12]
Amblystoma punctatum	1	2	3	Edgeworth
tigrinum	1	2	3	"
Triton	1			Gaupp
Siredon pisciformis	1	2?	3?	Gaupp, Stöhr
Desmognathus	1	1	1	Edgeworth
Spelerpes	1	1	2	Wiedersheim
Plethodon cinereus	1	1	1	Edgeworth
Amphiuma tridactylum	1	2	2	Winslow
Megalobatrachus maximus	1	2	2	Wiedersheim
Menopoma	1	1	2	Edgeworth
Hynobius nebulosa	1	1	2	"
Salamandrella keyserlingii	1	1	2	"
Ranodon	1	1	2	"
Necturus	1	2	3	Platt
Siren	1	1	1	Parker, Edgeworth
Rana	1	2	3	Gaupp, Parker
Hyla cærulea	1	2	3	Kesteven
aurea	1	2	3	"
Limnodynastes peronii	1	2	3	"
Ichthyophis	1		2?	Winslow
Siphonops	1		2	Edgeworth

TABLE III.

The ascending process of the quadrate is always attached to a trabecular derivative, but at varying levels, as follows:

Forms	At the level of cranial base.	To the trabecular wall.	To the *tænia marginata*.	Authority.
Neoceratodus		+[13]		Edgeworth
Protopterus	+?			Agar
Lepidosiren	+			"
Salamandrella		+[13]		Edgeworth
Ranodon		+[13]		"
Cryptobranchus		+[13]		"
Menopoma		+[13]		"
Hynobius		+[13]		"
Amblystoma		+[13]		Winslow
Spelerpes		+		Wiedersheim
Desmognathus		+[13]		Edgeworth
Plethodon		+		"
Amphiuma		+[13]		Winslow
Siren		+		Parker
Triton		+[13]		Gaupp
Siredon		+		"
Rana		+[13]		"
Hyla		+[13]		Kesteven
Limnodynastes		+[13]		"
Ichthyophis			+	Winslow
Siphonops			+	Edgeworth

There is a continuity, temporary or permanent, between the palato-quadrate and trabecular cartilage in the following forms, and always at, or close to, the cranial base: *Acanthias, Notidanus, Petromyzon,* some, if not all, Heterodontidæ and the Holocephali. In some of these the attachment rises on the side wall well above the base level, but in all the primary attachment was, as stated, at or near the base level.

[12] See also Edgeworth.—Trans. Roy. Soc. Edin., liv, 1926, pp. 719-720.
[13] Below the centre of the height of the wall.

TABLE IV.*

In (The basal process fuses with the :—)	Trabecula.	Junction of trabecula and parachordal.	Basal plate.	Perfacial commissure.	Floor of auditory capsule.
Protopterus	+				
Leoidosiren	+				
Acanthias	+[14]				
Notidanus	? +[14]				
Lepidosteus	+[14]				
Ceratodus		+			
Menopoma			+		
Megalobatrachus ..			+		
Siren			+		
Siphonops			+[14]		
Ichthyophis			A joint		
Amblystoma				+	
Necturus			+		
Triton					+
Salamandra					+
Desmognathus ..					+
Spelerpes					+
Plethodon					+[14]
Amphiuma					+
Hynobius					+
Salamandrella ..					+[14]
Ranodon					+[14]
ANURA					+[14]

* From Edgeworth.—Journ. Anat., lix, 1925, pp. 225-264.

Note.—The amphibian forms have been arranged so as to bring together those having similar attachments, and this arrangement is quite out of accord with their natural classification.

TABLE V.*

Dipnoi	Monimostylic	Streptostylic
Neoceratodus	+	
Protopterus	+	
Lepidosiren	+	

	Amphibia	Larva		Adult	
		Monimostylic	Semi-streptostylic	Monimostylic	Semi-streptostylic
[15] **Urodela**					
Amblystomidæ	*Amblystoma punctatum* and *tigrinum*	+		+	
Salamnadridæ	*Triton cristatus*	+		+	
	Salamandra atra	+		+	
Plethodontidæ	*Desmognathus fuscus*	+		+	
	Spelerpes bislineatus	+		+	
	Plethodon cinereus			early + adult	older + adult
Amphiumidæ	*Amphiuma tridactylum*	+		+	
Hynobidæ	Hynobius nebulosus	[16] + earlier	+ later		+
	Salamandrella keyserlingii	+ earlier	+ later		+
	Ranodon sibericus	+			+
Cryptobranchidæ	*Megalobatrachus maximus*	+		+	
	Menopoma alleghaniense	+		+	
Proteidæ	Necturus maculatus	+		+	
Sirenidæ	Siren lacertina	+			
Anura					
	Rana	+			+
Gymnophiona					streptostylic
	Ichthyophis glutinosus		+		+
	Siphonops braziliensis		+		+

* From Edgeworth.—Journ. Anat., lix, 1925, pp. 225-264.

Edgeworth draws attention to the fact that those forms which I have italicized are monimostylic in both larval and adult stages, and that with the exception of the gymnophiones all three dipnoans and every amphibian studied is monimostylic in the early stage.

[14] Subsequently a joint.

[15] The classification of Dunn is here followed.

[16] s. Hynobius keyserlingii.

Important facts which appear in the tables may be summarized as follows:

1. With the exception of *Petromyzon*, *Lepidosteus* and two of the Dipnoi there is actual, or circumstantial, evidence that the mandibular arch arises independently, not attached at any point to the chondrocranium, in every anamniote whose development has as yet been studied.

2. In the exceptional cases the connection of the primordium of the arch is with the trabecula where it occurs posteriorly.

3. In every amphibian in which the first attachment of the mandibular arch posteriorly has been observed, that attachment is by the ascending process. In no case has an otic or basal attachment been found without an attachment by the ascending process as well. True, in late larval stages it is not uncommon to find the ascending process absorbed and the basal attachment still present; this probably happens in all Anura, but also in all of them the ascending process is probably the first to gain attachment to the chondrocranium.

4. The ascending process is never attached to a parachordal derivative, but always to the trabecular wall (usually at or near the cranial base), or, in the gymnophiones, to the *tænia marginata*.

Not uncommonly the earliest attachment of the ascending process is to the low trabecular crest, but it is never carried dorsad with the upward growth of the crest; that grows past it, as it were.

5. The attachment by a basal process is later than that by the ascending process.

6. The point of "basal" attachment is to various parachordal structures or the otic capsule in the Amphibia, but to a trabecula in the fishes and Dipnoi.

7. The varying position of the basal attachment in the Amphibia shows no agreement with their natural grouping.

8. We can recognize a primary and a secondary streptostylic condition in the Amphibia.

As stated above, it is generally agreed that the pregnathostomes had a chondrocranium into which the special sense capsules had already been incorporated, and that the visceral arches were not differentiated. Sooner or later, however (archignathostomes) the first arch must have become modified. Presumably, because of its position in front of the others, it functioned as a jaw before there was any modification.

As a result of this function it became modified so that its upper half on each side moved as a single entity, and likewise its lower half; this resulted in the loss of any joints there may have been in the upper and lower segments, and in the perfection of the joint between the two halves.

This stage is surely represented by the early embryos of all but a few of the Anamniota, wherein we find the maxillo-mandibular arch arising quite independently of all other skeletal structures; similar to, and yet recognizably different from, the other arches.

I have ventured to designate these hypothetical early vertebrates "neognathostomes," and the condition of the mandibular arch "astylic." It is assumed that in the neognathostomes the primitive jaw was still attached in a manner similar to the other visceral arches, and that neither upper nor lower jaw was yet more fixed than upper and lower halves of the other arches. Notwithstanding this, the lower half will have been the more mobile, for the upper would

have been limited in its dorsi-ventral range by the fibrous union of its upper and anterior end with the under side of the chondrocranium.

It would appear that in the further modification of the arch, the upper end of the mandibular segment early became structurally continuous with the lateral expansion of the ethmoid, for we find cartilaginous or procartilaginous continuity here at some time in the development of representatives from most groups of anamniotes. It is of constant occurrence throughout the Anura, very generally present in larval stages of the Urodela and in those urodeles in which the continuity is broken there is, as also in the gymnophiones, evidence that such continuity has been but recently lost from the ontogeny. The anterior structural continuity of the palato-pterygoid and the ethmoid plate has been recorded in several Teleostei, as a temporary condition in early embryonic life, and among the elasmobranchs it is found in the adult Holocephali, and it is not improbable that the anterior articulation of various selachians will be found to have been preceded by cartilaginous or procartilaginous continuity, as demonstrated for *Acanthias* by Sewertzoff.[16a] Amongst the surviving ganoids *Lepidosteus* is apparently alone in presenting the continuity here under review.

Discussing the various modifications in the forward attachment of the palato-pterygoid, Edgeworth[17] concludes that: "These phenomena indicate an ancestral Urodelan condition in which the pterygoid process was continuous anteriorly with the trabecula. . ."

In view of the facts detailed above it would seem reasonable to assume that the primitive forms in which this forward attachment was present in the adult condition, were ancestral, not only to the urodeles, but to all the fishes as well, and it is not improbable that this was the first definite attachment of the arch. Holding this belief, I have designated these hypothetical ancestors "Archistylica" or "archistylic gnathostomes." This question will be dealt with in greater detail later.

There was now developed a definite fixed upper jaw and moving lower jaw. The articulation between the two was not yet fixed in any definite manner, but moved with the rest of the visceral arches. The need for fixation of this joint was imperative, and modification of the posterior relations of the arch took place in two directions. On the one hand the upper segment of the second arch was impressed into the service of the first and the hyoid (protohyostylic) suspension resulted, on the other hand the posterior end of the mandibular arch developed certain special processes whereby it became directly attached to the chondrocranium (autostylic suspension).

It is, of course, possible that the hyostylic suspension was antecedent to the autostylic, but I am of the opinion that this was not so, for on that hypothesis the complete elimination of the hyostylic phase from the history of the autostylic forms, with the single exception of *Neoceratodus*, seems inexplicable in view of the fact that both astylic and archistylic conditions are clearly recognizable in so many of them.

In this connection, and supporting the view taken, it may be mentioned that amongst the earliest known fossil vertebrata we find both hyostylic and autostylic forms.

[16a] Sewertzoff.—Festschr. Kupffer, 1899, pp. 281-320.
[17] Edgeworth.—Journal Anat., lix, 1925, p. 234.

There is not wanting evidence that there are two kinds of hyostylism, and two kinds of autostylism;[18] in addition *Lepidosteus* and *Megalichthys* present one, if not two, other types of suspension, which are neither autostylic nor hyostylic, but may be a combination of both.

It seems reasonable, then, to assume that the two outstanding types of mandibular fixation found in the Anamniota have been independently derived from the archistylic condition.

An analysis of the further modification of the suspension will involve us in an examination of the modern groups of anamniotes; this will be attempted later.

I turn next to a consideration of the probable course of evolution of the swim-bladder and lung.

3. *The Evolution of the Lungs.*

Kerr[19] sees in the swim-bladder of the fishes a modified lung. His history of the probable evolution commences with a "primitive condition of a lung, communicating with the pharynx by a ventrally placed glottis . . . ." The reason for this belief is to be found in the concluding portion of this same sentence: "for we have seen that the embryonic rudiment of the organ in the most archaic forms possessing it is a typical lung-rudiment." The archaic forms here referred to are *Polypterus* and the dipnoans, and it should be noted before proceeding further that the Heterocerci are equally as ancient as the Crossopterygii and Dipnoi, and that the surviving archaic Actinopterygii have well developed swim-bladders opening into the fore-gut *dorsally.*

It will at once be conceded that the primitive lung must have evolved from something much more simple, and if that something much more simple was, as Bridge[20] suggests, a glandular caecum opening dorsally into the fore-gut, I cannot understand why this could not have been modified to act either as a swim-bladder or as a lung directly, without first evolving as a lung and then becoming further modified to act as a hydrostatic organ.

Bridge does not enlarge on his suggestion, but on a previous page (p. 298) he implies that the swim-bladder may be represented among selachians "by a small caecum embedded in the dorsal wall of the œsophagus and communicating with its cavity" which was described in *Mustelus, Galeus,* and *Acanthias* by Miklouho-Maclay. I have not been able to find other references to these structures; it would be interesting to ascertain whether they are of common occurrence in the adult or embryonic stages of the elasmobranchs.

There is one set of facts that would appear to render highly probable the past occurrence of the beginning of the air-bladder and lung in the pro-elasmobranch stock. It is as follows: In so many features do the Chondrostei* resemble the elasmobranchs that they may be justifiably

* Throughout this paper I have used the term Chondrostei as Zittel[21] does, but, excluding the Belonorhynchidæ, which appear to be misplaced here on account of their diphycercal tail The well developed opercular apparatus of the Palæoniscidæ and Platysomidæ surely indicate that these fish were hyostylic after the manner of the Teleostei (neohyostylic).

[18] The autostylism of the Holocephali is a very different thing to that of the Dipnoi and amphibians.

[19] Kerr.—Text Book of Embryology, 1919, Vol. ii, p. 173.

[20] Bridge.—*In* The Cambridge Natural History, vii, 1904, p. 309.

[21] Zittel.—Text Book of Palæontology, transl. C. R. Eastman, 1902.

termed elasmobranchs which possess both an air-bladder and true bones. These are no mere parallelisms, but real identities of structure which indicate a much closer relationship for the Chondrostei to the elasmobranchs than to any bony fishes. Now, if this be correct, it follows that since the Chondrostei are derived from the elasmobranch stock and have in common with the other bony fishes a swim-bladder, then we are justified in assuming that, prior to those modifications which gave rise on the one hand to the elasmobranchs and on the other to the bony fishes, there was present in the parent stock the potential swim-bladder.

This question of the relationships of the Chondrostei will be returned to later; for the present it will be taken as established that they are more truly elasmobranchs than teleostomes.

We have then evidence that the swim-bladder has evolved from some structure that was present in the common stock from which both teleostomes and elasmobranchs have evolved; that structure, it is further assumed, was a glandular caecum situated above and opening dorsally into the fore end of the gut.

The history of its evolution was, perhaps, somewhat as follows: It would be foolish to speculate as to its original function, but sooner or later, owing to its flaccid walls, open mouth, and dorsal situation, it came to act, quite passively, as a trap or receptacle for gases gulped in with the food or resulting from putrefaction in the gut. This interfered with its original function, and resulted in its becoming aborted, or developing an ability to deal with the new conditions. In the latter case there resulted an air-bladder with the power of controlling its gaseous contents by glandular activity and/or muscular action. From this condition there evolved on the one hand the various types of swim-bladder and on the other the lungs.

In the diagrammatic presentation of my thesis which appears on an earlier page, it will be seen that I have recognized pre-, proto-, and pene-pulmonate stages in the evolution of the air-bladder, and differentiated between apulmonate, eupulmonate and pulmoneid resultants of the final stages in the evolution. These latter will be returned to later.

The foregoing considerations lead us to believe that the dipnoans, ganoids and elasmobranchs are but different groups derived from one common family.

A study of the geological record leads one to the further belief that the family flourished during the Silurian age, and that at the close thereof it was already differentiated into those groups which were soon to yield the dipnoans and the various orders of the ganoids and elasmobranchs, and one is finally led to the belief that this Silurian vertebrate fauna presented a general elasmobranch facies.

To the student of the evolution of the Vertebrata the Silurian was the elasmobranch age.

We turn now to a consideration of the segregation or differentiation of the members of this fauna into dipnoan, ganoid and elasmobranch groups, that took place during the early Mesozoic; and this may be aptly termed the teleostome age.

The Early Mesozoic or Teleostome Age.

1. *The Elasmobranchs and the Chondrostei.*

The Chondrostei undoubtedly combine the features of the Elasmobranchei and the Teleostomi, and in explanation thereof one has to choose from two

alternatives; either they have retained the elasmobranch features inherited from their ancestors or they have reverted thereto. If the Chondrostei be classified as teleostomes, then there must be more or less tacit assumption that they have reverted to the elasmobranch type. This must surely be so, because it seems very probable that the teleostomes have evolved from an elasmobranch-like stock. By so much as they have departed from the stock type have they become teleostomes.

Now the Chondrostei have departed from the stock type to the extent of having acquired a swim-bladder and true bone, but herein they have moved along a road common to both dipnoans and teleostomes; they are certainly not dipnoans; neither, it is believed, are they teleostomes.

Parker[22] says of the skull of *Acipenser* that "the development of the basis cranii and cranial walls is very similar to what is seen in the selachians; and the after modifications are essentially alike, except that in the sturgeon the cartilage is very massive, and the occipito-cervical articulation is not formed. The separation of a large symplectic, and a lesser interhyal segment, the complex metapterygoid plate, and the partial ossification of the visceral arches, are all modifications which separate this from the selachian type."

Budgett[23] (1901) speaks of the suspensorial apparatus of the larval *Polypterus* as exhibiting a condition "exactly intermediate between that of the hyostylic selachians and the Teleostei."

Whilst it would appear that Edgeworth[24] has finally demonstrated the soundness of Gegenbaur's theory, and shown that the hyomandibular of the Selachii, teleostomes and *Ceratodus* are truly homologous, it is yet a fact that there are the two distinct types of hyostylism, as implied in the quotation from Budgett.

The hyostylism of the Chondrostei is of the selachian type, and that this is no reversion, but a true genetic character, is surely evidenced by the relation of muscle C_2hd (Edgeworth[25]).

Bridge[26] briefly reviews the characters of Chondrostei as here restricted, and differentiates between characters typically elasmobranch (primitive) and those due to degeneration. His primitive characters are all of them found in most, if not all the elasmobranchs, whilst every one of his characters of degeneration may, with equal justification, be regarded as a distinct advance on those of the acanthode elasmobranchs.

Bridge remarks that from an evolutionary point of view it is significant that the Chondrosteidæ do not make their appearance until the Palæoniscidæ are approaching extinction. It is equally, and to my mind more, significant that they make their appearance in the Lias, thus replacing the Acanthodei, which die out soon after the Lower Permian.

The peripheral distribution of the cranial nerves in *Amia*, *Lepidosteus*, *Polyodon*, *Scaphirhynchus*, and *Acipenser* was reviewed by Norris. It is noteworthy that throughout the review it was found convenient to discuss *Amia* and *Lepidosteus* together and the other three forms together. Norris uses the term "Ganoid" as one of convenience rather than of exactness, and states that "the

[22] Parker.—Philosophical Transactions, clxxiii, 1882, 443-492.
[23] Budgett.—The Work of J. S. Budgett, 4to., Cambridge, 1907.
[24] Edgeworth.—Journ. Anat., lx, 1926, pp. 173-193.
[25] Edgeworth.—*Loc. cit.*, pp. 190-191.
[26] Bridge.—*In* Cambridge Natural History, vii, Fishes, 1904, pp. 489-490.

fishes so designated have certain nervous as well as other similarities, which mark them off rather sharply from the shark-like forms on the one hand, but less distinctly from true teleosts on the other."

This, I take it, is a general statement whose form was determined rather by accepted views than by the observations made, for on a later page we meet the statement: "In their cranial nerves the Chondrostei are plainly shark-like," and again, describing the origin of the trigemino-facial complex: "In *Polyodon*, *Scaphirhynchus* and *Acipenser* the 5th and 7th roots are more closely compacted than in *Amia* and *Lepidosteus*, i.e., are more shark-like."

It is concluded that the Chondrostei are really a group of the Elasmobranchii, and that it were well to place them along with the Acanthodei.

Returning again for a moment to the two types of hyostylism, there can be little doubt that the elasmobranch type is the more primitive, and we are justified in believing that the teleostome type is a direct modification thereof. Since the two types are characteristic, it will be helpful in descriptive work and discussion if we have separate designations for them. The primitive may be aptly termed protohyostylic, and the teleostome type neohyostylic.

2. *The Crossopterygii, Dipnoi, and Amphibia.*

There appears to be such general agreement that these groups are more nearly related one to another than to other fishes that little need be written under this head.

1. We have Kerr's considered statement—quoted below (p. 181)—relevant to the phenomena of development in the three groups.

2. External gills are developed in all the members of the three groups, and in no other forms.

3. The anterior, stomodeal portion of the buccal cavity arises in a similar manner in crossopterygians, Dipnoi and urodeles, and is more or less characteristic of these forms.

4. The crossopterygian lung approaches that of the Dipnoi more closely than does that of other fishes, and the glottis opens ventrally into the fore-gut as in the dipnoans and amphibians.

5. The arteries to the lung are derived from the fourth pair of efferent branchial vessels as in the dipnoans. Herein the Crossopterygii share a character with *Amia*.

6. The skull of the Crossopterygii presents striking resemblances to that of the amphibian. Kesteven[27] has written: "The Ganoids present three distinct types of cranium, the Elasmobranch is represented by the Acipenserids, the Amphibian by the Crossopterygii and the Teleostean type by the Holostei."

Both Watson and Gregory depend very largely on cranial structures to support the contention that the Amphibia are derived from crossopterygian ancestors.

3. *The Dipnoi and the Amphibia.*

With the exception of Kerr, Edgeworth, and Kellicott, recent writers have agreed that the ancestors of the amphibians must be sought among the crossopterygians, and to this group they also look for the ancestors of the dipnoans.

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[27] Kesteven.—Journn. Anat., lxi, 1926, p. 120.

Apparently Cope[28] first expressed these views, and they were independently arrived at by Kingsley.[29] They were adopted by Dollo[30] and Bauer[31] and stated again at great length by Kingsley[32] in 1900.

Bridge[33] derives both dipnoans and amphibians from some "crossopterygian ancestor with Elasmobranch tendencies" and is of the opinion that they "subsequently became modified in certain respects on parallel lines."

Kerr[34] expresses his views thus: "I may here merely indicate that on the whole the general phenomena of development in *Polypterus* show frequent striking resemblances with what occur in Dipnoans and in the lower Amphibians. I believe that these resemblances are sufficient by themselves to indicate the probability that the Teleostomes, the Dipnoans and the Amphibians have arisen in phylogeny from a common stem, which would in turn probably have diverged from the ancestral Selachian stock. The ancestors of the Amniota probably diverged about one or about several points from the region of the stem common to Dipnoi and Amphibia." While admitting such vague speculative conclusions, we are, in my opinion, here, as in other phylogenetic speculations, absolutely debarred from making such statements as that the "Amniota are derived from the 'Amphibia' or the 'Dipnoi' from the 'Crossopterygii'."

Edgeworth,[35] writing of the posterior relations of the pterygo-quadrate in dipnoans and Amphibia continues: "This and many other phenomena, both skeletal and muscular, show that Dipnoi and Amphibia are descended from a common ancestral stock with a primarily fixed pterygo-quadrate (a monimostylic condition)."

Gregory[36] is of the opinion that the "known Dipnoi are all excluded from direct ancestry to the Amphibia by the specialized character of the dentition, including the complex radially arranged tritorial plates on the roof of the mouth and on the inner side of the mandible and the loss of marginal teeth on the premaxillæ, maxillæ and dentaries." In his concluding paragraphs Gregory applies the name "Osteichthyes" to the primitive common ancestor of the dipnoans, Actinopterygii and Crossopterygii, and believes that from this stock the above three groups became differentiated, and that from the last the Tetrapoda evolved.

Watson[37] finds in a "curious type of tooth change . . . . a strong additional reason for regarding the Tetrapoda as derived from" the crossopterygian fishes.

Broom,[38] following Watson, makes two of those statements which Kerr, I think rightly, says we are "absolutely debarred from making." He writes: "The skull in some types [Cotylosaurian], such as *Seymouria*, agrees strikingly with that of the large Carboniferous Stegocephalians such as *Loxomma*, and there can be little doubt that the Cotylosaurs are directly descended from such Carboniferous forms, as these latter have themselves sprung from Devonian Crossopterygians as maintained by Watson."

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[28] Cope.—Amer. Phil. Soc., Proc., 1892, xxx.
[29] Kingsley.—Refers, in Tuft's College Studies, No. 6, 1900, p. 250, to a paper published in 1892, which I cannot trace.
[30] Dollo.—Bull. Soc. Belge Geol. et Pal., ix, 1895, p. 79-128
[31] Bauer.—Anat. Anz., xi, 1896, p.
[32] Kingsley.—Tuft's College Studies, No. 6, 1900, pp. 203-274.
[33] Bridge.—*In* Cambridge Natural History, vii, Fishes, 1904, p. 519.
[34] Kerr.—*In* The Work of J. S. Budgett, 4to., Cambridge, 1907, p. 274.
[35] Edgeworth.—Trans. Roy. Soc. Edinb., liv, 1926, p. 720.
[36] Gregory.—Annals New York Acad. Sci., xxvi, 1915, pp. 317-383.
[37] Watson.—Mem. Proc. Manchester Lit. Phil. Soc., lvii, 1912, p. 5.
[38] Broom.—Phil. Trans. (B), ccvi, 1914, p. 8.

With the single exception of Bridge, and to a lesser extent Dollo, all these writers arrive at their conclusions from the study of a limited number of features of anatomy, osteology, or development.

My interest in this problem arose in the following way. Some few years ago I commenced the study of the skull in the fishes, with a view to arriving at a comprehensive review that would harmonize the modifications which it presents, and of determining the homologies of its components with those of the tetrapod skulls. After having, as I thought, cleared the way of difficulties by the discovery that the so-called premaxillæ and maxillæ of the teleostean skull were really labial bones not represented in the tetrapod series, I[39] still found that it was impossible to harmonize the structure of the skull of the Chondrostei and dipnoans with that of the rest of the bony fishes. My search for the explanation of that impossibility has led to the present contribution. Very naturally my first idea was that, had I sufficient knowledge, the difficulties would melt away and that I should come to an understanding of the apparent differences. The contrary has happened, and I am now convinced that the correct explanation is that different evolutionary roads have been followed, and that as a result there are now in existence three distinct types of cranium among the bony fishes (including the Dipnoi as such).

From these years of study I find that I am almost, but not quite, in agreement with Kerr and Edgeworth.

I am of the opinion that the archistylic prepulmonate gnathostomes yielded two great divisions, the elasmobranchs and Chondrostei on the one hand and the teleostomes and Dipnoi on the other ("Ganoid stock" of the diagram). This latter group, to which I would restrict the term Osteichthyes, next yielded the Actinopterygii on the one hand and the Crossopterygii and Dipnoi on the other.

In the Crossopterygii we see the result of a conflict between inherited potential and acquired potential; in the result they have failed to advance along those lanes which yielded the dipnoans, but, the inherited potential gaining the upper hand, they have been halted at the commencement of that career, and have remained fishes. The Dipnoi, on the other hand, have been impelled along roads of evolution which ultimately led to the amphibians.

I am, indeed, absolutely convinced that the dipnoans are the most primitive amphibians that we know. This is not to say that I deem the amphibians to have been derived from the dipnoans as we know them. (No one, as far I am aware, derives the urodeles from the gymnophiones or the Anura from the urodeles, or *vice versa*, though many writers have expressed convictions as to which of these is the most primitive).

In arriving at this conclusion I am especially swayed by the form and development of the brain, the type of autostylism, the form and development of the heart, and arterial and venous systems, and the possession of a true pelvic girdle.

There can be little doubt that the amphibian ancestors must have possessed all these features, wherein the dipnoans differ fundamentally from the rest of the fishes, and therefore it appears that we must conclude that they approach

[39] Kesteven.—Journ. Anat., lvi, 1922, pp. 307-324. RECORDS AUSTR. MUSEUM, xv, 1926, pp. 132-140.

nearer to the amphibian stock than any of the fishes, even if we still argue the question whether we shall regard them as fishes or amphibians.

Having stated my conclusions, I proceed to discuss the evidence on which they are founded.

"The relations (similarities?) of the Dipneusti to the Amphibia are somewhat deceptive, and it seems improbable that the former group stands in the direct line of the amphibian descent. In most of their structural features not directly or remotely associated with air breathing the Dipneusti are true fishes, and the striking resemblances which they present to the amphibians in the vascular system and lungs seem to be rather the outcome of physiological convergence, associated with adaptive and parallel modifications in structure, and due to the influence of a similar environment, than indicative of direct ancestral relations. With more reason it may be inferred that both the Dipneusti and the Amphibia have been derived from some primitive crossopterygian ancestor with elasmobranch tendencies, and subsequently became modified in certain respects on parallel lines" (Bridge[40]).

This quotation is taken from the only review I have been able to find of the phylogeny of the dipnoans, written by one who has studied the group in its entirety; that is to say, by one who has studied, not only the adult features of the recent and fossil forms, but also the anatomy and development of the recent forms, and also the anatomy and development of the other groups of fishes. One cannot but conclude that the views expressed are directly traceable to an uncritical reading of Dollo's work on the phylogeny of the dipnoans, for there was surely ample evidence scattered through the previous pages of his review of the anatomy and development of the fishes to have corrected the concluding inferences.

The paragraph is a little ambiguous, and it may be that I have misunderstood it. He states his conviction that the resemblances are not due to direct ancestral relationship, but suggests that both forms have been derived from some (one?) primitive crossopterygian. Surely we have here direct ancestral relationship, and, if so, why postulate modification along parallel lines? Why not assume that the features in common were already present or evolving in that common ancestor? It will be shown later that this is the more reasonable assumption, and from it will follow the conclusion that the common ancestor was not a crossopterygian, but a fish that, in certain features, was more primitive than any known crossopterygian, and yet presented many, if not all, of the distinctive features of the dipnoans, not, perhaps, so well developed as in the dipnoan, but, nevertheless, recognizable.

There are a large number of characters wherein the dipnoans resemble the amphibians more than other fishes do, and, though the contrary has been argued, not one of them is devoid of phylogenetic significance. I give a list of the characters in question and discuss the more important of them.

Adult Features.

The mode of swimming.

Autostylic and monimostylic suspension of the maxillo-mandibular arch.

The fenestration of the nasal roof.

The homology of the supra-orbital bone with the amphibian prefrontal.

[40] Bridge.—*In* Cambridge Natural History, vii, Fishes, 1904, p. 519.

The form of the brain.
The possession of internal nares.
The division of the auricle into right and left halves.
Certain features of the arterial system.
Certain features of the venous system.
The possession of true external gills.
The form of the air-bladder and its function.
The structure and position of the glottis.
The possession of an epiglottis.
The possession of a true pelvic girdle.
The mating call.

Embryological and Larval Characters.

The general course of the development.
The development of the external form.
The mode of development of the two-chambered auricle.
The origin of the amphibian characters in the arterial system.
The origin of the amphibian characters in the venous system.
The mode of origin of the cerebral hemispheres.
The early form of the chondrocranium.
The development of the buccal cavity.
The form of the pituitary involution.
The development of the flask glands.
The development of the cement organs.
The history of the palato-quadrate.
The history of certain cranial myotomes and their derived muscles.

The mode of swimming.—"When we consider the *clumsy movements* of the only existing fish retaining this type of fin (*Ceratodus*) . . . ." (Kerr[41]). This is the only reference I can find in literature to the peculiarity of the mode of progression of *Neoceratodus* through the water. Whereas the great majority of fish appear to strike the water with the tail, a few of weak muscular development in the caudal region, and practically all fish when sick and exhausted, appear to undulate through the water much as a snake travels over the ground. In these cases the body flexures are, so far as my observations serve me, but two in number, producing a very wide open S-curve. Now the swimming motions of *Neoceratodus* recall these undulations; there is a complete absence of the tail "stroke," but more than that, the undulations follow one another so that there appears to be a sequence of them, and they recall in a most striking manner the wagging of the "tadpole's" tail.

It is a fact not without significance that this is the mode of swimming of practically all fish larvæ. Again I speak from personal observation, for I can find nothing in literature on the matter. The opportunities of a single individual for making such observations are of necessity limited as to the variety of forms observed. The youngest pelagic fish larvæ "wiggle" through the water; as they increase in size the number of flexures of the body become less. Growing a little older, the youngster will, when frightened, start off with a jump, wiggle

[41] Kerr.—*In* The Work of J. S. Budgett, 1907, p. 277.

rapidly for a little space and then seem to be propelled through the water with the body held rigid; closer observation discovers the tail striking the water with a lateral and oblique stroke. The adult starts off with a similar jump, the result of a powerful lateral sweep of the tail, and then continues with a rigid body.

Since it is characteristic of larval forms, "wiggling" or undulatory progression may be regarded as having been the primitive mode of swimming, and there is ample confirmation of this inference in the metameric arrangement of the longitudinal musculature. The interest of these phenomena to our present problem lies in the fact that alone among the compact vertebrata, the adult dipnoans and the amphibians retain an archaic mode of swimming. Is this evidence that in their common ancestry there was none which had developed the tail as *the* organ of swimming?

The autostylic and monimostylic suspension of the maxillo-mandibular arch.—The mode of attachment of the quadrate to the neurocranium in the dipnoans is essentially and in *Neoceratodus* identically the same as in the amphibians, excepting only the aberrant *Ichthyophis* and *Siphonops*. Herein the lung-fishes differ, it may be said, fundamentally from the rest of the fishes and resemble the frogs. As this matter will be returned to in the next section it may be left for fuller discussion there.

The fenestration of the nasal roof.—The similarity noted here and the fact that it did not extend to other fish was noted by Bridge.[42] Having described the fenestration, in a footnote he remarks: "With the exception of the Dipnoi, this curious fenestration of the nasal roof occurs in no other vertebrates except certain Urodele Amphibia, and affords another instance of the many homoplastic modifications which are to be noted in the two groups." It is a fact that, as he further notes, this fenestration has been observed, but hardly more than indicated, in certain selachians.

Like several of the other features, which are here passed in review, wherein the lung-fishes resemble the amphibians more than any other of the fishes, this is not advanced as being in itself of phylogenetic significance, but considered in conjunction with all the others it lends weight, and receives weight. It is certainly significant that so "many homoplastic modifications" are found in the Dipnoi, whilst none are found in the ganoids which lived side by side with them. Why, one cannot but ask, are the resemblances between the crossopterygians and amphibians regarded as of phylogenetic import, while those between Dipnoi and amphibians must be deemed merely homoplastic?

The homology of the supra-orbital bone with the amphibian prefrontal.—This is a homology maintained by Bridge,[43] but Kesteven[44] has maintained the homology of the teleostean ectethmoid and the amphibian prefrontal; if he be correct, this feature is not a peculiarity of the dipnoans.

The form of the brain.—Herein we have a feature which is unquestionably of phylogenetic import. Here, in the Dipnoi, we have the inception of those modifications of the cerebral hemispheres which culminate in the mammalian neopallium. It is quite beyond question that, whereas there is a fundamental

[42] Bridge.—Trans. Zool. Soc. Lond., xiv, 1898, pp. 325-376.
[43] Bridge.—*Loc. cit.*, pp. 332-333.
[44] Kesteven.—Journ. Anat., lvi, 1922, p.

similarity in the brains of all other fishes, there is an equally fundamental departure from that type in the dipnoan brain, and that we must turn to the amphibians for a similar brain, and, further, that having so turned, we find the similarity between dipnoan and amphibian brains as complete as that between the rest of the fishes among themselves.

The possession of internal nares may be merely a homoplastic variation, but equally it may have been derived from an ancestor common to the gnathostomes possessing them. As far as my reading serves me, it would appear that the dipnoi are the only animals below the Amphibia so endowed.

The division of the auricle into right and left halves.—That this does not occur in other fish is, of course, not in need of telling, but, together with the form of the lung and the related modifications of the arterial and venous systems, it has been regarded as the result of parallel modification under the drive of similar environment. On the other hand, it is equally well known that in certain of the ganoids, especially *Polypterus*, the air-bladder acts as a subsidiary respiratory organ (Budgett[45]). There is not wanting evidence that in the Teleostei also the air-bladder acts as a subsidiary respiratory organ (Jobert[46]). Although this is so, it is also a fact that in neither *Amia*, *Lepidosteus*, *Polypterus* nor the teleosts investigated by Jobert is there any indication of those modifications of the heart and vascular system which, in the dipnoans, resemble the amphibian arrangement. We have here, then, circumstantial evidence that there was nothing in the mere assumption of a respiratory function by the air-bladder to condition variations in the vascular system after the amphibian pattern; some other circumstance or factor must be invoked. Since it *did* work in the same manner on both dipnoans and amphibians, it is at least not unreasonable to postulate "inherited potential."

The arterial system.—Bridge[47] briefly reviews the arterial systems of the dipnoans as follows: "As in so many other features of its anatomy, *Neoceratodus* exhibits in its arterial system abundant evidence of the widespreading affinities of the group to which it belongs. In its branchial arterial system *Neoceratodus* presents a singular combination of features which, individually, are characteristic of Amphibia and Elasmobranchs. Special amphibian features may be noted in the origin of the afferent branchial arteries almost simultaneously from the anterior end of the conus arteriosus; in the origin of a lingual artery from the efferent vessel of the first arch; and in the derivation on either side of a pulmonary artery from the fourth epibranchial artery. Agreement with Elasmobranchs is to be found in the presence of two efferent branchial vessels in each branchial arch, although the relations of these vessels are more primitive than in most adult Elasmobranchs, inasmuch as the two efferent vessels of the *same* arch unite to form an epibranchial artery; and also in the origin and distribution of the anterior and posterior carotids. Lastly may be mentioned the fact that *Neoceratodus* agrees not only with the Amphibia, but also with those generalized Teleostomi, *Polypterus* and *Amia*, in the mode of origin of the great arteries for the air-bladder" (from the fourth pair of efferent branchial vessels). This last is described as a "significant resemblance" (p. 338).

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[45] Budgett.—Proc. Zool. Soc., 1903, pp. 10-11.
[46] Jobert.—Ann. Sci. Nat. (6), vii, 1878.
[47] Bridge.—*In* The Cambridge Natural History, vii, Fishes, 1904, p. 339.

"Of the two remaining Dipnoi, the arterial system of *Protopterus* is better known than that of *Lepidosiren*, but in both cases further research is needed before a satisfactory comparison can be made with *Neoceratodus* and other Vertebrates. It is evident, nevertheless, that both genera differ from *Neoceratodus* in approximating more closely to the Amphibia than the lower fishes, in so far as the branchial part of the arterial system is concerned." [*Lepidosteus* in its arterial system is said to offer "a singularly interesting transition from the Elasmobranch to the Teleost" (*l.c.*, p. 334).]

In this comparative review Bridge was struck by the dual nature of the similitudes of the arterial system, those wherein it resembled the amphibian on the one hand and those wherein it resembled the elasmobranch on the other; characters new and characters archaic.

Of the new characters, conceivably, the origin of pulmonary arteries from the fourth pair of efferent branchial vessels may be causally "post hoc" to the assumption of respiratory function by the air-bladder, but not so the peculiar origin of the lingual artery or the bunching together of the afferent branchial vessels at the anterior end of the conus arteriosus; else why has it not happened in *Polypterus* and *Amia*? In both of these the air-bladder functions as a respiratory organ supplied by pulmonary arteries similar to those of *Neoceratodus*.

The venous system.—Features of this system which may be regarded as pointing to a common ancestor for the dipnoans and the Amphibia are the renal-portal vein, the inferior vena cava and the anterior abdominal vein. Bridge[48] writes: "Less is known of the venous system of *Protopterus* [than of that of *Neoceratodus*], but it is certain, nevertheless, that it presents a more advanced grade of evolution . . . ., and, except for the doubt as to the existence of the anterior abdominal vein, it is essentially similar to that of a Urodele Amphibian in which the right posterior cardinal vein has aborted." There is no evidence that any of these features is merely a homoplastic variation.

The external gills.—Herein the Dipnoi share a distinction with the Crossopterygii as well as the Amphibia, and we are to assume that the feature was present in their common ancestor, but it is not evidence that the ancestor in question was more crossopterygian than dipnoan in character.

The form of the air-bladder and its function.—Although the air-bladder of *Polypterus* is more complex than that of other ganoids, and to that extent it stands as an intermediate stage between the dipnoans and other fishes, it is not of great phylogenetic significance because it has not associated with it those other modifications of the respiratory and vascular systems which in their totality bring about the striking resemblance between the dipnoans and the amphibians. In the case of *Polypterus* the increase in the complexity of the walls of the air-bladder is a single isolated modification, and, moreover, one that may with justice be regarded as resulting from the influence of the environment; although the resemblance is marked, it well may be an analogous modification and not a homologous one. The development of a glottis might also be regarded as but another part of the same modification. On the other hand, the ventral position of the glottis cannot be so regarded; there are forms with air-bladder almost as complex and a dorsal glottis. It is believed that this position of the glottis is

[48] Bridge.—*In* The Cambridge Natural History, vii, 1904, p. 327.

evidence of the existence of closer relationship between the Crossopterygii and the dipnoans than between the former and other ganoids. There is other evidence in support of this belief.

The possession of a fibro-cartilaginous epiglottis by two of the dipnoans is not, in itself, significant, but being superadded to the glottis it is; unless we assume that it was evolved *pari passu* with the glottis, it surely pushes the origin of the glottis further back in time. Does it not indicate that the respiratory function of the air-bladder in the dipnoan ancestry was so well established that already there was diversity in the superadded structure amongst the members of the group?

The mating call of *Neoceratodus* is essentially similar to that of the frogs. I know of no fish with a mating call.

The development of the cerebral hemispheres.—Kerr (1902), when describing the development of the brain of *Lepidosiren*, describes the hemispheres as arising as "two separate lateral bulgings of the wall of the thalamencephalon" and notes that herein the development of the brain of *Lepidosiren* presents features of fundamental importance to a proper understanding of the morphology of the vertebrate brain generally. Professor Kerr returns to this question in his account of the development of *Polypterus* (1907), and his remarks are worthy of quotation in full.[49]

"As has been pointed out elsewhere, I hold the view of von Baer, Reichert, Goette and Studnička that the true cerebral hemispheres *as seen in Vertebrata from Dipnoi upwards*, are to be looked upon as primitively paired structures—as lateral evaginations of the wall of the primitive fore-brain, developed doubtless in order to give space for the great increase in the mass of nerve matter in this region correlated with the increasing development of the olfactory organ. I find it difficult to realize how anyone can fail to be convinced that this is the correct view to take of the morphology of the hemispheres, *looking at their mode of development in the Dipnoi and Amphibia* and to their adult relations in the higher forms where that potent disturbing factor—the yolk sac—is present. In *Polypterus* a quite similar increase takes place in the mass of nervous matter forming the sides of the primitive fore-brain, but in this case there is no evagination of the brain wall to form hemispheres, beyond the small pair of olfactory lobes. Room is found for the nervous mass in other ways: (1) the side wall becomes greatly thickened to form the so-called 'basal ganglia'; (2) the thalamencephalon increases much in length and (3) the thickened portion becomes slightly invaginated instead of being evaginated. The nervous material which corresponds with the whole of the hemisphere in the higher forms—including the pallium or mantle—lies in the thickened wall of the thalamencephalon. What is ordinarily termed the pallium in the Crossopterygians is nothing more nor less than the roof of the thalamencephalon, which is of course epithelial here as elsewhere. The conditions in Actinopterygian Ganoids and Teleosts are obviously similar to those in *Polypterus*: what is ordinarily called the pallium in these forms is simply the epithelial roof of the primitive fore-brain, while the so-called basal ganglia are thickened walls including what corresponds to the whole of the hemispheres in higher forms." Kerr concludes by pointing out that Studnička "has already given utterance to exactly the same views."

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[49] Kerr.—*In* The Work of J. S. Budgett, 1907, pp. 195-284.

Clearly we are compelled to conclude that the form and mode of development of the cerebral hemispheres are features wherein the Dipnoi differ fundamentally from the fishes and resemble the amphibians.

Gregory[50] finds that the Dipnoi and Crossopterygii were derived from a common ancestor, and concludes his paragraph thus: "Nor should the difference in brain structure of these modern forms outweigh the above-mentioned resemblance, for there is no evidence that the brains of the Devonian Crossopterygii were any more divergent from each other than were the other parts of the body."

With this conclusion I am unable to agree. If our knowledge of the recent dipnoans were confined to fossil skeletal structures only, we would unhesitatingly classify them along with the rest of the dipnoans, and we should find that they all differed from the crossopterygians in one fundamental respect—they are autostylic, while the Crossopterygii are without exception neohyostylic. In the very nature of the problem we can have no direct evidence as to the form of the Devonian brains, but it is surely more likely that the Devonian dipnoans resembled the recent in this respect, having inherited this brain form from an earlier ancestor, from whom also the Amphibia inherited it. If this view be not accepted, we must accept one of two alternatives: (1) the dipnoans and amphibians independently developed this type of brain; (2) this type of brain was possessed by the common ancestor of the crossopterygians, dipnoans and amphibians, but the crossopterygians reverted to the ichthyic type.

Neither of these alternatives is acceptable.

With a view to emphasizing the character of the fore-brain, it is proposed to designate the whole of the fishes "Archiprosencephalica" and the rest of the Anamniota and the Amniota "Neopresencephalica."

The history of the palato-pterygo-quadrate.—The significance of the autostylic condition of the Amphibia and of the Dipnoi was discussed by Huxley,[51] Bridge,[52] Dollo,[53] Goodrich,[54] and Luther[55] (1909, 1913, 1914), all of whom agreed that the autostylism was a secondary character. According to Edgeworth, Fürbringer was the first to cast doubts on the correctness of this view. He was "of the opinion that the primitive condition was one in which the mandibular and hyoid bars articulated separately with the cranium" (Edgeworth[56]).

Edgeworth's opinion on the question is as follows: "The sum of these skeletal phenomena suggests that Selachii, Batoidei and Teleostomi are descended from autostylic and monimostylic ancestors in which there was a pterygo-quadrate united to the chondrocranium at three points. The anterior end was probably fused with the ethmoid region. The middle region was probably fused with the trabecula by a basal process. The otic process was probably fused with the auditory capsule. This condition was lost and a streptostylic one was developed. *Heptanchus* is autostylic, the others amphistylic or hyostylic, whilst various traces are left in developmental phenomena or in adult anatomy of what existed in the past" (*loc. cit.*, p. 257).

[50] Gregory.—Ann. New York Acad. Sci., xxvi, 1915, p. 325.
[51] Huxley.—Proc. Zool. Soc. Lond., 1876, pp. 24-59.
[52] Bridge.—Trans. Zool. Soc. Lond., xiv, 1898, pp. 325-376. *In* Cambridge Natural History, vii, Fishes, 1904.
[53] Dollo.—Bull. Soc. Belge Geol. Pal., ix, 1895, pp. 79-128.
[54] Goodrich.—*In* Lankester, A Treatise on Zoology, ix, 1909.
[55] Luther.—*Fide* Edgeworth, Journ. Anat., lix, 1925, pp. 225-264.
[56] Edgeworth.—Journ. Anat., lix, 1925, pp. 225.

In the main I find myself in agreement with Fürbringer and Edgeworth, though I cannot agree with the latter that any of the hyostylic elasmobranchs or teleosteans have descended from autostylic ancestors. I would point out that he has himself collected and produced evidence that, with the exception of *Lepidosteus*, *Petromyzon*, and two of the dipnoans, every anamniote, not excluding the Holocephali, sufficiently studied has an originally quite free palato-pterygo-quadrate cartilage (see Table I, antea, p. 172). This should surely be interpreted to indicate that the primitive condition was a streptostylic condition. I cannot agree, however, that this primitive streptostylism was a hyostylism.

Dollo wrote of the autostylism of the Dipnoi: "c'est un pure conséquence de l'adaptation à un régime triturateur très accentue (mylodont), dans un but de consolidation de l'appareil masticatoir.

1. En premier lieu, la morphologie démontre, certainement, sans réplique, que les Vertébrés autostyliques dérivent de Vertébrés hyostyliques.

Et l'Embryologie confirm cette conclusion."

This statement is supported by a quotation from Cope wherein Huxley is stated to have shown that the Batrachia are hyostylic in early stages and become autostylic in later stages of development.

I have sought in vain for the embryological evidence that gives confirmation to the statement that autostylic vertebrata are derived from hyostylic forms.

Kerr,[57] too, is among those who believe that the primitive condition was one in which there was an attachment of the mandibular arch posteriorly.

He states that "the usually accepted idea of the mandibular arch is to regard it as a half-hoop shaped cartilage resembling the other arches, to which is added a forwardly projecting outgrowth—the palato-pterygoid bar—which forms the primitive upper jaw skeleton."

I have not met elsewhere this idea of an *added* palato-quadrate, nor can I find justification for the suggestion in the facts.

There is, of course, growth in length of the maxillary segment of the first arch as there is growth in length of the mandibular, or as there is growth from the centre both ways in length of the branchial and hyoid arches, but this growth in length of the dorsal segment of the first arch is not fundamentally greater than in the other arches and does not suggest the addition of anything not added in the growth of the other arches.

In its most primitive form, in the early embryos of elasmobranchs, the dorsal and anterior end of the first arch is almost in contact with the trabecula behind the rudiment of the nasal sac, lying close to the edge of the future mouth. With increase in size of the individual and the increasing gape, the upper and lower segments of the arch are lengthened proportionately, becoming segmented one from the other in the middle of the length of the arch just as do the other arches.

As the upper segment grows forward it retains its close relation to the trabecula, and in some cases becomes temporarily continuous therewith, but it should be noted that this point of temporary continuity, or articulation, is not back close to the posterior end of the trabecula near the otic capsule, but anteriorly near the nasal capsule, either in front of, beneath, or behind it.

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[57] Kerr.—Text Book of Embryology, ii, 1919, p. 320.

The hinder end of the upper segment of this first arch does not become approximated to the skull base, but becomes attached to the lower end of the upper half of the second arch, hyomandibular.

Turning now to the amphibians, it is clearly the forward end of the arch which so commonly becomes attached to and continuous with the lateral expansion from the forward end of the trabecula immediately behind the nasal capsule, whilst it is from the hinder end that are produced those processes, ascending, otic, and basal, whereby the posterior end of the bar becomes knit to, and continuous with, the trabecula, otic capsule, and parachordal cartilages.

This hinder end is the morphological centre of the original arch, and is the point of fission into upper and lower segments; it is not, as stated by Kerr, "the dorsal portion of the original arch" (*loc. cit.*, p. 320).

Now, of all the points of cartilaginous continuity, temporary or permanent, which have been noted between the rudiment of the mandibular arch and the neurocranium, this anterior one between it and the trabecula in the neighbourhood of the nasal capsule is the only one which has been found to occur in every one of the major divisions of the Anamniota, hence I have been led to believe that it is the most primitive.

In 1884 Cope[58] described the structure of the skull of *Didymodus* and in the general discussion arising out of this study he expressed it as his opinion that the Holocephali were the most primitive of the elasmobranchs and traces thence the evolution of all the other fishes, the dipnoans and the amphibians. In the course of this discussion he quite plainly indicates that he regards the fixed upper jaw of the Holocephali as the primitive condition, for he says that these forms have not yet "differentiated a suspensorium."

Portion of Kingsley's[59] comment hereon is as follows: "In this there are several important errors. In the first place the assumption that the monimostylic condition is the more primitive is at variance with every known fact relating to the comparative anatomy and embryology of the visceral arches."

I believe that there is no room for doubt that the maxillo-mandibular apparatus has been evolved from a visceral arch essentially similar to the arches behind it, and similar to the branchial arches as we see them to-day. If this be so it is surely unreasonable to assume that the primitive jaw was one in which the mandibular segment was in structural continuity fore and aft with the neural cranium. There must have been transitional stages between the original arch and the attached arch; there was surely the slightly modified, the more modified, and the completely metamorphosed arch.

If an originally "floating" visceral arch has become structurally continuous with the cranium at two points, it is not unreasonable to assume that the nearest point of contact was the first to be converted to the continuous state; undoubtedly the dorsal end was the nearest. Thus far I have the support of Kerr, but we differ as to what shall be interpreted as representing the original dorsal end of the arch in the amphibians.

Again, if the maxillo-mandibular apparatus has evolved from a visceral arch by the development and improvement of a joint at the point of division into dorsal and ventral halves, as a first or early step, then surely, as the first arch

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[58] Cope.—Proc. Amer. Phil. Soc., xxi, 1884, p. 585

[59] Kingsley.—Tuft's College Studies, No. 6, 1900, p. 248.

must have been attached to the second by muscular and fibrous tissue, the evolution of the protohyostylic condition should have been possible directly, without the intervention of a preliminary autostylic condition. Indeed had we but a few more examples of the incorporation of a portion of the hyoid arch into the basal attachment of the mandibular arch, as in *Neoceratodus*, we should have to assume that this was the primitive method of suspension. It is only the complete absence of any indication of the inclusion of any separate cartilages in the processes of attachment of the autostylic forms that justifies the assumption that this type of suspension has also been evolved directly from a primitive gnathostome as one of the original modes of fixation of the upper jaw posteriorly.

In the Teleostei we see the development of a metapterygoid process that may well be regarded as an incomplete attempt at autostylism, and, indeed, we have no evidence that it was not in this way, without any structural continuity between the maxillary and hyomandibular segments, that autostylism was developed.

In the present state of our knowledge, the final decision as to whether the greater probability is that the autostylic is an original or secondary mode of fixation of the maxillo-mandibular joint, must be by the personal equation. I am of the opinion that it has been evolved from a primitive suspension from the second arch, without that arch becoming modified to act as the suspensorium of the first.

However, whatever be the decision on this point, Edgeworth has left us little room for doubt that the autostylism of the Dipnoi and amphibians is a feature of fundamental importance in which these creatures differ from the fishes. This he has proven not only by his clear demonstration of the essential similarity and identity of the three processes of attachment, but also by his demonstration of the modification in the mode of development of the muscles of mastication in the amphibians and dipnoans on the one hand and the fishes on the other. His conclusion quoted above (p. 181) is fully justified by his evidence.

Though his main contention, as just stated, appears completely justified by his evidence, it is not so clear that he is correct in regarding the basal attachment as the most primitive, and the *processus ascendens* as being "probably a later phylogenetic development."[60]

It must be pointed out that throughout the Amphibia, the *processus ascendens* is the first to develop, and that, with the exception of *Siphonops* and *Ichthyophis*, it presents identical relations throughout the class. On the other hand the basal process develops later, becomes attached later and presents varying relations to the neural cranium, as to its point of attachment, and to the nerves, and finally these variations show absolutely no relation, in their occurrence, to the natural grouping of the creatures themselves. (See Tables II, III and IV, antea.)

Our knowledge of the development of the processes of attachment in the Dipnoi is incomplete; unless the development in *Lepidosiren* is similar to that of *Ceratodus* it would seem that there are three different modes of development. Edgeworth[61] states that in *Neoceratodus* the palato-pterygoid arises as an independent structure, and subsequently becomes attached by the same three processes as are found throughout the Amphibia. Agar[62] has shown that in *Protopterus* the first chondrified portion is found as a spur from the trabecula behind the floor of the

[60] Edgeworth.—Journ. Anat., lix, 1925, p. 258.
[61] Edgeworth.—Journ. Anat., lvii, 1923, pp. 238-244.
[62] Agar.—Trans. Roy. Soc. Edinb., xlv, 1906, pp. 49-64.

gasserian recess. His description and illustration of his findings in *Lepidosiren* indicate that it develops quite otherwise in this form, for, although he speaks of a basal attachment, it appears quite certain that in the earliest stage he illustrates the only attachment is by the *processus oticus*, and that a *processus ascendens* is present in the next stage.

The condition in *Protopterus* is closely paralleled in *Petromyzon*, and, although I now think that one can place but little confidence in phylogenetic deductions based on the conditions in the cyclostomes, it is not entirely without significance that, as I have previously pointed out,[63] the so-called basal attachment of *Petromyzon* is in truth by a *processus ascendens*, as judged by its position and relation to the nerves.

Turning now to the evidence for an attachment by a *processus basalis* in the fishes, this evidence is very scanty, and fails to convince that it was of general occurrence in ancestral forms.

In *Acanthias* Sewertzoff discovered that, prior to the establishment of the basal joint, there was continuity of the so-called basal process with the trabecula.[64] This basal joint is, however, so far forward that it can hardly be homologized with the basal joint of the amphibians and the dipnoans.

In *Lepidosteus* Veit found that the articulation of the maxillary rudiment with the basipterygoid process is preceded by a continuity in embryonic cartilage. In this case there appears no reason to cavil at the identification of the joint with that in the Amphibia.

Unless the basal contact in *Gymnarchus* described by Assheton[65]—and probably present in others of the Mormyridæ (if one may judge from their adult structure as described by Ridewood[66]) and in the Symbranchidæ—can be regarded as homologous with the basal attachment of the amphibians, we have but one single instance of such a continuity among the fishes.

The evidence for the homology of the spiracular cartilage and the otic process is more convincing. Personally, I incline to the opinion that the metapterygoid process of the Teleostei is also homologous with the spiracular cartilage, and therefore with the *processus oticus* of the dipnoans and the amphibians.

It would seem that W. K. Parker and Bettany had the same inclination, for in the figures illustrating the chapters on the development of the Elasmobranch skull they consistently indicate the spiracular cartilage with the letters "M.Pt.", and in the interpretation of the lettering these letters are translated "metapterygoid" (Parker and Bettany[67]).

It therefore appears that either the attachment by the ascending process, or that by the *processus oticus*, is the most primitive of the three attachments of the amphibian autostylism posteriorly, but the evidence does not permit us to decide in favour of either.

It would be of interest to learn whether the evidence of Edgeworth's wonderful series of *Neoceratodus* is such that his oto-quadrate cannot be regarded as a spiracular cartilage. Neither he, Allis, de Beer nor Schmalhausen appear to have considered the little pellicle of cartilage in this light.

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[63] Kesteven.—Journ. Proc. Roy. Soc. N.S.W., lix, 1925, p. 250.
[64] Sewertzoff.—Festschr. Kupffer, 1899, pp. 281-320.
[65] Assheton.—*In* The Work of J. S. Budgett, 1907, pp. 293-421.
[66] Ridewood.—Journ. Linn. Soc., xxix, 1904, pp. 188-217.
[67] Parker and Bettany.—The Morphology of the Skull, 1877.

The development of the vascular and respiratory systems.—Since writing the earlier part of this section—the Dipnoi and the Amphibia—I have received a copy of Kellicott's paper. From that I learn that both he and Semon have expressed views relative to the evolution of the Dipnoi similar to my own, though they did not regard the Dipnoi as primitive amphibians.

To my mind Kellicott's thorough and detailed work should have established the views of himself and Semon, and the scant attention bestowed upon his work by subsequent writers on the evolution of the Tetrapods, is a distinct reflection upon their ability to appreciate work in other branches of comparative anatomy and embryology than their own specialties.

This review, of the features of anatomy and phenomena of development in the Anamniota which bear upon the evolution of the various groups, would be incomplete without a summary of the features of importance under the above heading, but for me to undertake such a review when Kellicott has presented the facts so well and briefly in his "General Conclusions" would be foolishness. I therefore quote that section from his work almost at length.[68]

"It was stated in the Introduction that the immediate object of this investigation was to test embryologically the evidence, based upon anatomical considerations, for certain supposedly Elasmobranch and Amphibian characters seen in the adult vascular system of *Ceratodus*. Throughout the course of this paper, as the development of the vascular and respiratory systems has been reviewed, the embryological evidence has necessitated continual subtraction from the list of real Elasmobranch resemblances and continual addition to the list of Amphibian characters. For instance, the Elasmobranch similarities seen in the arrangement and distribution of the carotid arteries and the connection between the anterior carotid artery and the vessels of the hyoid arch, the double efferent branchial artery, the hyoidean gill, all prove to be in the nature of parallelisms and are preceded by Ganoid or Amphibian arrangements; the arrangement of the veins of the head and of the lateral cutaneous veins resembles as closely the Amphibian as the Elasmobranch. On the other hand the Amphibian resemblances in the adult system all have been confirmed—the origin of the afferent branchial arteries, the arrangement of the epibranchial arteries, the relations of the lingual artery, the abdominal vein, the renal-portal vein, are typically Amphibian, and, excepting in the Cyclostomes, it is only in the Amphibian group (*Necturus*) that there is a continuity between the cardinal veins and the branches of the caudal vein, comparable with the arrangement in *Ceratodus*.

"Furthermore, embryologically the similarities to the Elasmobranchs were only in such characters as are common also to the Amphibia, for instance, the method of formation of the primitive aortic arch and the arrangement of the lateral cutaneous veins. But the Amphibian resemblances are extremely numerous —the method of mesoblast formation, the hypoblastic nature of the cardiac endothelium and the details of its formation, the development of the thyroid body, nearly all of the numerous details of the formation and development of the heart, the arrangement of the visceral arches, the nature of the gill-pouches and gills, the presence of elongate "larval gills," the arrangement of the afferent branchial arteries and their relations to the conus, the early development of the branchial arteries, the formation and relations of the hyomandibular artery, the develop-

[68] Kellicott.—Mem. New York Acad. Sci., ii, 19055, pp. 243-244.

ment of the lingual artery, the formation and relations of the carotid arteries throughout a long period, the relations between the posterior cardinal veins and the pronephros, the later condition of the posterior trunk veins, the development of the inferior jugular veins, the development of the abdominal vein, the arrangement of the vitello-intestinal vein and the formation from it of the hepatic and subintestinal veins, the formation of the hepatic-portal vein and its relations with the subintestinal vein, the development of the lung—in all of these respects, to enumerate only the more important, there is close, usually exact correspondence between *Ceratodus* and the Amphibia.

"Characters more or less intermediate between Elasmobranch and Amphibian arrangements are the number of gill pouches, the development of the efferent branchial arteries which resembles the Ganoid rather than the Amphibian, the arrangement of the interrenal veins, and the frequent anastomoses between the posterior cardinal veins. . .

"The immediate object of this investigation as stated above is, of course, really a part of the larger question of the relationships of the Dipnoi. It is unwise to attempt exact or complete statements in the entire absence of knowledge concerning the development of the Crossopterygii, especially since such knowledge is soon to be expected, but it is absolutely impossible to believe that the Amphibian resemblances seen in *Ceratodus* in the development of the vascular, respiratory and urinogenital systems, as well as throughout the early processes of development, are in the nature of parallelisms. In the light of their embryology, it is impossible to believe that the Dipnoi and the Amphibia are not closely related and that they have not travelled for a time along the same path at some period during their history."

When to this striking evidence are added the facts that these two groups are eupulmonate, autostylic, and neoprosencephalic, differing in all three respects fundamentally from the rest of the Anamniota, it may be fairly claimed that Kellicott's conclusion is as completely proven as circumstantial evidence *can* prove it.

Finally, it is also contended that all the recent work on the development of the Crossopterygii and Dipnoi has indicated that the latter are more nearly akin to the Amphibia than to the former, and that this fact should be admitted in classifications by assigning the Dipnoi a place among the Amphibia.

The Evolution of the Cheiropterygium.

The evolution of the cheiropterygium is so wrapped in obscurity that Kingsley's[69] summary—"No known facts of either embryology or palæontology throw any certain light on the matter"—is still very true. The latest survey of the question that I am acquainted with is that of Gregory,[70] who briefly reviews the previous work.

It must be admitted that Gregory is correct in his statement that: "The endoskeleton of the pectoral limb of the Rhipidistian offers the only remote approach to the tetrapod type hitherto known among recent or fossil types"; and whilst one notes that he is in agreement with Patten, Broom, and Watson as to

[69] Kingsley.—Outlines of Comparative Anatomy of Vertebrates, 3rd Edition, Philadelphia, 1926.
[70] Gregory.—Annals New York Acad. Sci., xxvi, 1915, pp. 317-383.

which elements shall be regarded as homologous with humerus, radius, and ulna, one also notes his choice of the word "remote" and feels that therein he was wise.

Gregory further expresses the opinion that the basal and central line of pieces in the fin of *Eusthenopteron* are probably homologous with the mesaxial series of *Neoceratodus*, and no reason is apparent why one should not agree with this suggestion.

There is other evidence that the dipnoan fin was the starting point for the evolution of the tetrapod limbs, which, so far as I am aware, has not heretofore been advanced. I find that among the large number of fins which I have been able to dissect, the dipnoan fin alone is provided with a segmented musculature, the segments of which are placed along the length of the fin, on both sides thereof, so that the segments can be flexed independently.

This extension of the muscle along the length of the fin was probably the first step in the development of the effectually jointed limb; certainly such an extension must have preceded the modification of the skeleton, and in all probability it caused the modifications. This excursion of the muscles along the axis of the fin was a more important factor in the evolution of the limb than the mere development of a fleshy muscular lobe at its place of origin from the body. The muscles of this basal lobe could but actuate the fin as a whole, and condition the more perfect development of the single joint. The fleshy lobe of the rhipidistian fishes was no greater than, if indeed it was as large as those of such typical forms as *Parascyllium collare* amongst the sharks and *Periophthalmus barbatus* amongst the Teleostei.

The evidence is, indeed, so scanty that theorizing on the evolution of the tetrapod limbs amounts to little more than speculation, but the following summary is at least not unreasonable.

The primitive limb was probably an archipterygium as defined by Gegenbauer, and it may have been derived from an external gill as postulated by Kerr. The concentration of muscle fibres at the base of the archipterygium caused the shortening and broadening of the structure with the ultimate development of the various types of ichthyopterygia. The development of muscular tissue along the length of the archipterygium and its segmental arrangement led to the improvement of the joints between the skeletal units, and to the development of the cheiropterygium.

Though it may be that the homologies of the proximal pieces of the fin of *Eusthenopteron* are as suggested by Gregory and others, it is equally probable that the fin presents an early stage in the transition from the form with a single piece next the proximal element and those with three or more which are typical of the recent fishes.

Anomalous Structures and Resemblances.

In the preceding pages I have endeavoured to pass in review those phenomena of development and features of adult anatomy which in the Anamniota appear to throw light on the vexed question of their mutual relations. From this review certain phenomena and mutual similarities have been omitted, either because they are completely discordant with any scheme of relationship of the various groups, or because they throw no light of any kind on the questions that have been discussed.

Some of the more anomalous of these facts, however, should be briefly reviewed, if only that their anomaly may be emphasized, and the need of further investigation pointed out.

1. One of these anomalous facts has been already mentioned in passing in paragraph 5, page 180.

2. The features of gastrulation of the Teleostei closely resemble those met with in the elasmobranchs. But Kerr[71] believes that we must regard this as a phenomenon of convergence, seeing that the general evidence of morphology points a much closer relationship to the ganoids than to the recent elasmobranchs. In the surviving ganoids (p. 47) "the gastrulation clearly belongs to the same general type as that of the Lampreys, Amphibians and Lung-fishes. That of *Acipenser* seems nearly to resemble that of *Polypterus*, and that of *Amia* and more especially that of *Lepidosteus* to point towards the mode of gastrulation found in the modern Teleosts."

It seems probable that all these forms present a primitive vertebrate mode of gastrulation, more or less modified by the quantity of yolk present. Clearly, if the mode of gastrulation of *Acipenser* resembles most nearly that of *Polypterus*, one cannot seize on, as being of phylogenetic significance, the resemblance of that of *Amia* to that of the modern teleosts. *Acipenser* is more closely related to the elasmobranch stock than to any of the ganoids. Again, Kerr has himself stated his opinion that *Polypterus*, in its embryology, more nearly resembles the amphibians and dipnoans than any of the ganoids.

3. The history of the palato-pterygoid arch in *Lepidosteus* is to me absolutely an enigma. In the early stages it presents what appears to be complete homology of structure and relation with the amphibian arch. On the other hand, the investing and replacing bones later developed clearly indicate a close relationship to the modern teleosts. Further than this, *Lepidosteus* stands absolutely alone in the adult articulations of the pterygo-palatal arch, unless it be that a similar condition is present in *Megalichthys*, but on this point one cannot come to a decision from Watson's inadequate description of the joint with the basi-pterygoid process. As Watson makes no comparison of the bones with any of the surviving ganoids, the absence of any reference to *Lepidosteus* cannot be taken as an indication that one should not have been made.[72]

4. In the development of the palato-pterygoid arch in *Gymnarchus* we have the phenomena of development in the Holocephali reproduced with remarkable approximation. In this case it is so obviously impossible to look to community of origin for an explanation of the phenomenon that with confidence we say this is clearly a case of analogy. I incline to the same view in the case of *Lepidosteus*.

5. The characteristic manner of formation of the buccal cavity of the Urodela and Dipnoi might be regarded as inherited from a common ancestor, but one cannot lay stress on this feature, because the more primitive mode of formation of the buccal cavity by "simple walling in of a special area of skin"[73] is found in forms more primitive and more advanced.

6. One might be tempted to seize upon the possession of a pronephros by ganoids, lung-fishes and amphibians as evidence of a common ancestor distinct

[71] Kerr.—Text Book of Embryology, ii, 1919, p. 46.
[72] Watson.—Mem. and Proc. Manchester Lit. and Phil. Soc., lvii, 1, 1912.
[73] Kerr.—*Loc. cit.*, p. 281.

from that of the elasmobranchs. But against this one has to remember that in many features the Chondrostei resemble more closely the selachians than other fishes. Sedgwick[74] pointed out that the pronephros appears to be reduced in forms having heavily yolked eggs and no real larval existence.

7. The Holocephali and lung-fishes present a peculiar and surely primitive character in the absence of segmentation of the secondary sheath of the notochord.

8. In cyclostomes and sturgeons the secondary sheath remains as a tough fibrous structure and does not become chondrified.

9. In crossopterygian ganoids dorsal and ventral ribs are present, in actinopterygian ganoids, teleosts, and dipnoans the ribs are ventral, whilst in elasmobranchs, amphibians, and amniotes they are dorsal (Kerr[75]). Here we have a rib "pie"—to borrow a word from the printers—which it is quite impossible to sort with phylogenetic tweezers.

10. The case of the cyclostomes calls for special mention. They have, of course, in the past been very generally regarded as exceedingly primitive forms (a view which I have myself subscribed to), but are they? We know absolutely nothing of their ancestry, we do not definitely know of one single fossil representative of the group *Palæospondylus* has been identified as an amphibian by W. J. and I. Sollas,[76] and Kerr sees in this identification confirmation of his own, which was that the little fossil is a larval dipnoan (Kerr[77]).

As far as the head skeleton is concerned, it is arguable that the embryo is in some respects more advanced than the adult. The development of the palato-quadrate as a process of the hinder end of the trabecula is without parallel, except in two of the dipnoans. In these, that feature is surely the result of tachygenesis; the weight of evidence clearly indicates an independent origin as the primitive. Kerr (*loc. cit.*, p. 318) expresses the opinion that there is not sufficient evidence to doubt that the visceral skeleton of the cyclostomes is homologous with that of the gnathostomes. If, then, the cyclostomes be phylogenetically "pregnathostomes," how comes it that they have in the larval stage a more advanced palato-quadrate than most of the gnathostomes?

Such are the differences and such the points of resemblance of the cyclostomes, one to another, that it is not inconceivable that they are all degenerate forms of the same group of ancestors, and, whilst not actually polyphyletic, are yet not strictly homophyletic; perhaps homoiphyletic would convey the idea.

One cannot overlook the fact that a bilobed olfactory region of the brain related to an azygous organ is surely evidence that the organ in question was originally paired.

However, whatever be the truth in this question, it would be unwise to attempt to generalize on the evidence of the anatomy or development of these very especially isolated forms; for the present, at least, it would seem wiser to attempt to explain them by the mass of evidence presented by the development and adult form of the rest of the vertebrata than would be the converse.

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[74] Sedgwick.—Quart. Journ. Micro. Sci., xxi, 1881, pp. 432-468.
[75] Kerr.—Text Book of Embryology, ii, 1919, p. 303.
[76] Sollas.—Phil. Trans. (B), cxcvi, 1903, pp. 267-294.
[77] Kerr.—*Loc. cit.*, p. 310.

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AUSTRALIAN MOLLUSCAN NOTES.

No. 1.

By

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(Plates xxii-xxv.)

To these RECORDS I have contributed notes on the mollusca trawled off the continental shelf,[1] and also stray notes on other forms from New South Wales. More material is being received from the trawlers through the assistance of Captain K. Möller, and another enthusiast, Mr. W. Dingeldei. The latter has also collected many specimens from the dredge dump at Dundas, and some interesting records are here chronicled from his efforts. I have reported[2] many strange molluscs in Sydney Harbour secured by means of examining the dredgings made by the dredge "Triton." The master, Captain Comtesse, has continued his researches, and has also obtained the assistance of other members of his crew, and recently Mr. E. F. Nash was placed in command of the dumping of the material at Dundas on the Parramatta River. Examination of the dump has revealed many interesting species and has shown that the tropical fauna was more extensive than anticipated, and was immensely rich. Later some of the more interesting points may be detailed, but as the continuous search is still productive speculation may be withheld. One point may be emphasized, however, and that is that the tropical forms appear to show more relationship with those of New Caledonia than with those of the Queensland coast.

As in my previous articles, I have to thank Miss J. K. Allan and Mr. G. C. Clutton, of this Museum, for the excellent drawings and photographs which embellish this paper and which render the species easily recognizable.

Solemya velesiana sp. nov.

No large shells have yet been found after over one hundred years' search by excellent collectors, so that it seems reasonable to conclude that the Sydney shell is always small, and therefore a species distinct from the large shell inhabiting southern Australia, which, moreover, was described from King George's Sound, south-western Australia. The local species is more like the Queensland shell described as *Solemya terræreginæ* Iredale,[3] but more dilated anteriorly and more closely ribbed posteriorly.

The generic name *Solemya* was introduced by Lamarck with two species *australis* and *mediterranea*. Children in 1823 named *mediterranea* as type, observing that Lamarck's type was *australis*, an observation negativing his selec-

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[1] Iredale.—REC. AUST. MUS., xiv, 1925, pp. 243-270; xvii, 1929, pp. 157-189.
[2] Iredale.—Aust. Zool., v, 1929, pp. 337-352.
[3] Iredale.—Mem. Q'land Mus., ix, June 29, 1929, p. 262, pl. xxx, fig. 13.

tion. Gray selected in 1847 *mediterranea*, so in order to clarify the situation I introduce *Solemyarina* for these small species, designating *velesiana* as type, and it may be used for all the Australian species pending some decision on Children's action.

Ennucula gen. nov.

The type species of *Nucula* is *nucleus* Linné, a European species which differs appreciably from antipodean shells so classed, the latter having a notably oblique chondrophore, above which the teeth become much smaller, and the angle of opposition of the two rows of teeth is scarcely marked; further, the edge of the European shell is strongly denticulate, whereas ours is practically smooth.

Two or three species appear to have been confused under the name *consobrina* A. Adams and Angas, but Hedley[4] has figured the type and it has a rather small chondrophore with numerous teeth both anteriorly and posteriorly. A somewhat similar shell which has been lumped, but which agrees with Hedley's figure of the type of *simplex* A. Adams, is easily distinguished by the few teeth anteriorly and the long oblique chondrophore. This is the species Hedley referred to as *antipodum* Hanley from Port Stephens, but Hanley's species is very distinct and is not known yet from New South Wales. As A. Adam's name is invalid, I am naming the local shell *Ennucula astricta* sp. nov.

When these shells were being sorted it was noticed that less oblique shells which had been regarded as *obliqua* Lamarck from the Harbour differed from the true Tasmanian *obliqua* trawled off southern New South Wales in their smaller size, more elongate chondrophore, more posterior teeth and fewer teeth anteriorly succeeding the chondrophore. The pseudolunule was also less marked and the anterior side less elevated. It is therefore named *Ennucula duritas* sp. nov.

I have noted that *Nucula prætenta* was not a *Pronucula* but was a *Nucula*, that was in the broad sense. Specimens from 800 fathoms, 35 miles east of Sydney, identical with Smith's species, have the surface radially rayed, the inner margin of the shell denticulate and the hinge line more angulate than it is in *Ennucula*, the teeth more distant, the chondrophore small and scarcely exceeded by any teeth. A new genus *Deminucula* is therefore introduced for it.

Our deep-water form of *dilecta* from 300 fathoms east of Sydney is more elongate but otherwise agrees well with Smith's figure.

Grandaxinæa gen. nov.

When I described *Glycymeris magnificens*[5] I had only valves which had been dead for some time, but immediately afterwards Captain K. Möller brought in a number, including one perfect very recently dead valve. Consideration of this and the rest of our Glycymerids compels separation into three groups, one for *G. magnificens*, another for *G. flabellatus*, and the third for *G. flammeus*. By the usage of small groups we can more easily determine the species and work out their inter-relationships. Thus I introduce *Grandaxinæa*, naming *G. magnificens* as type, and we can then trace this group through its Neozelanic relations and its geological forbears. By proposing *Tucetona* for the group typified by *G. flabellatus* we can similarly determine its congeners, and the smooth shells may be

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[4] Hedley.—Proc. Linn. Soc. N.S.W., xxxviii, 1913, xvi, figs. 4, 6.
[5] Iredale.—Rec. Aust. Mus., xvii, Sept. 4, 1929, p. 161, pl. xxxviii, figs. 1, 2.

classed under *Veletuceta*, *G. flammeus* being named as type, though more than one genus may be here confused through inability to recognize the essential distinguishing characters. These will perhaps be determined by study of series of juvenile shells. Distribution of the local shells in these groups at once shows up the value of the groups; thus the anomalous *gealei* has been confused with *flabellatus*, but it is better classed under *Grandaxinæa* until more specimens are collected. I added *crebreliratus*[6] Sowerby for a northern shell and admitted *tenuicostatus* Reeve for a southern shell, but I find that *tenuicostatus* Reeve is undoubtedly the same shell that Sowerby described as *crebreliratus* from Moreton Bay, whence probably Reeve's specimens also came. Hedley introduced *capricorneus* for a shell common at the Capricorn Group, and this seems to be the same species. Lamy and Hedley both recognized the alliance but did not publish the identity, and then Lamy allowed *tenuicostatus* for the small shells sent from Victoria. Many were collected at Twofold Bay, and I wrote that the sculpture was stronger than that of *crebreliratus*, but that was the Sydney form wrongly so regarded. The true *crebreliratus* (*i.e.*, *tenuicostatus* Reeve) is more strongly sculptured than the southern shell, which I here name *Veletuceta fossa* sp. nov. The latter is also more circular in outline and the teeth smaller and closer, the periostracum less velvety. The shell from northern New South Wales recorded as *crebreliratus* is here named *Veletuceta thackwayi* sp. nov., and differs from the true *crebreliratus* in its weaker sculpture, its more angulate side and its persistent periostracum. These species will be figured comparatively later. It may be noted that in its angulation *V. thackwayi* recalls *V. fringilla* Angas,[7] which occurs along the mainland of Queensland, and is associated with *V. hanleyi* Angas[8] described from an unknown locality. If these two should prove identical *fringilla* Angas has both priority and locality, yet it has been regarded as a synonym of *hanleyi*.

A fine new species of *Melaxinæa* also occurs with these at Townsville, Innisfail, and elsewhere. It is just as flat as *M. labyrintha* Iredale and has the same generic hinge line, the teeth numbering twelve or thirteen on each side. It differs at sight in lacking the pronounced ears, being nearly circular, and the sculpture consists of radials, closely packed, with a fine lattice of threads; it is named *Melaxinæa litoralis*, sp. nov.

Versipella gen. nov.

When I dealt with Limopsid molluscs[9] I left in abeyance the form appearing in the New South Wales list under the name *Limopsis tenisoni* Tenison Woods as there appeared to be much confusion in connection with it. Recent criticism reveals the existence of two species, neither of which can be regarded as conspecific with *tenisoni*, and these are here described. The species most like *tenisoni* is not so oblique, is less cancellate, has fewer teeth; it can be named *Versipella soboles* gen. et sp. nov. The specimen selected as type is from 300 fathoms east of Sydney.

A very different kind of shell is trawled in deep water off the south coast of New South Wales, being larger and more oblique, with a broad ligamental area,

[6] Iredale.—Proc. Linn. Soc. N.S.W., xlix, 1924, p. 189.
[7] Angas.—Proc. Zool. Soc. (Lond.), 1872, p. 612, pl 42, fig. 10.
[8] Angas.—Proc. Zool. Soc. (Lond.), 1879, p. 418, pl. xxxv, fig. 3.
[9] Iredale.—Rec. Aust. Mus., xvii, Sept. 4, 1929, p. 159.

the teeth numerous and crowded, becoming misplaced posteriorly. This curious shell agrees in general with a Lower Miocene Patagonian fossil named *Limopsis insolita* Sowerby. I am naming the New South Wales shell *Senectidens dannevigi* gen. et sp. nov.

From 111 fathoms off Cape Byron, northern New South Wales, another species of *Aspalima* was secured. It is smaller, more strongly sculptured and has fewer hinge teeth than *Aspalima erecta*, and may be called *Aspalima solator* sp. nov.

It may be here recorded again that in the genus *Aspalima* the internal margins of the valves are strongly denticulate, a feature quite foreign to our other Limopsids, and one which indicates a different origin. A most curious species from the 100 fathom dredging off Wollongong, New South Wales, has the general aspect of a young Glycymerid and is not cancellate but with only concentric growth lines; the umbo is central and the shell is not oblique, a little broader than high. The hinge is composed of few teeth, five on each side, well separated though the ligamental pit does not intrude; the pit is well marked and narrow, thus definitely ranging the species with the Limopsids, and the margins of the valves are smooth. For this extraordinary little shell the genus *Glycilima* is proposed, the species being named *paradoxa*; it may be related to some fossils as there is a *Limopsis æquilatera*, but it does not agree in the features of the umbones and sculpture.

Cosa sagana sp. nov.

From off Wollongong, New South Wales, material was dredged by Hedley in 100 fathoms, and this dredging was not minutely worked out. In this two sets of unnamed "*Philobrya*" were found and are here indicated.

C. sagana differs from all the other New South Wales species of *Cosa* in being long and broad and having a very pronounced cap. The sculpture is stronger than that of *Hochstetteria inornata* Hedley, which it most approaches, but its hinge line is that of *Cosa*, most like that of *C. tatei*. Eight major rays can be counted, the cancellate sculpture being weak.

Cosa pharetra is also very distinct, being more circular than *pectinata*, more densely sculptured with radials, closely noduled by concentric lines. The hinge line is very long and slightly interrupted by the ligament only, and the cap is small and little raised.

Notomytilus crenatuliferus Tate (No. 40) must be omitted from our list as at present there is no authentic record of its occurrence.

Streptopinna saccata inusitata Iredale.

I introduced this genus to the Australian fauna[10] from specimens collected at Michaelmas Cay, north Queensland, and Caloundra, Queensland. My colleague, Mr. G. P. Whitley, Ichthyologist, was with me when both these were collected, and, being recently at Trial Bay, northern New South Wales, he collected many shells for me, and among them brought back a fragment which he regarded as referable to this species. This fragment was too small to base an unexpected addition to our list upon, but I agreed that it represented this shell. To our delight Mr. H. S. Mort brought in a small but perfect shell from Coff's Harbour, and thus

[10] Iredale.—Austr. Zool., iv, May 18, 1927, p. 333, pl. xlvi, figs. 9-11.

confirmed our conclusion and allowed indubitably the inclusion of such an interesting form. It has been suggested that *Streptopinna* was based on anomalous growths of different species, but in Australian waters, where we have many species of Pinnidæ, the shells allotted to *Streptopinna* are all conspecific and distinct in texture and sculpture from any of the species.

Malleus novelesianus sp. nov.

One of the strange shells brought into the Museum, usually from Broken Bay, is the large Hammer-head Oyster, and as specimens have accumulated they are seen to agree in the large hammer and to differ constantly from the tropical shells known as *Malleus albus* Lamarck.[11]

In the tropical shells the hammer-head is much shorter than the handle, and is also usually of weaker structure, whereas in the local shell the hammer-head is as large as the handle, sometimes even larger.

A curious little "hammer-oyster" which produces no hammer, and which has a peculiar corrugated nucleus, then extending irregularly, has been identified as *Malleus legumen* Reeve, but differs from that Philippine Island shell in this respect and in hinge features, and is here named *Parimalleus cursator* gen. et sp. nov.

Electroma zebra (Reeve).

Although specimens of this species had been collected more than once in these waters, it was not included by Hedley in the New South Wales list, but examination of the records leaves no doubt as to their authenticity, and the recent discoveries of tropical forms makes this a very commonplace visitor.

A rather common shell at Caloundra, south Queensland, which has also occurred in New South Wales, is included in our list as *Pteria lata* Gray. It is not that species, and has been figured by Reeve as *Avicula heteroptera*,[12] but it is not Lamarck's species of that name. The new name *Austropteria saltata* is provided for this species.

Pteria maura Reeve was described from Sydney, and, although it has not recently been met with, it has been collected at Port Curtis, Queensland, along with *Electroma zebra* (Reeve) and many specimens of *Austropteria saltata*. *P. maura* belongs to the genus *Austropteria*.

Spondylus prionifer sp. nov.

(Pl. xxiv, fig. 1.)

Some beautiful upper valves recalled the many spined tropical forms and suggested identity. Comparison with specimens recently collected in northern Queensland showed little difference, but the nomination was difficult, the only similar shells having been described from the Philippines. In the Sydney Harbour shells the spines are very numerous, twenty major rows and as many minor being counted on the early part of the whorl, while the major ones persist to the edge, developing long spines; the minor ones increase in number but not in strength. The colour of the dead shells is uniform pale red, whereas the Queensland shells are blotched. The spines are flattened and on their edges minutely

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[11] Lamarck.—Hist. Anim. s. Vert., vi, (1), 1819, p. 144.
[12] Reeve.—Conch. Icon., x, 1857, pl. xvi, sp. and fig. 67.

denticulate, the under-surface grooved. The inside is white, the outer edge simple and pink.

Length of small but perfect valve, 42 mm., breadth 40 mm., longest spine 15 mm.

Hab.—Sydney Harbour, New South Wales.

Plicatula essingtonensis elusa subsp. nov.

(Pl. xxv, figs. 5-6.)

The genus *Plicatula* is represented on the New South Wales list by the species *P. australis* Lamarck, although Whitelegge had previously used the name *P. imbricata* Menke. Many specimens secured by Comtesse and Nash are of the latter type, none resembling the species known from Queensland as *P. australis.*

Menke's name was preoccupied, so Finlay provided a substitute,[13] *P. menkeana,* but there was already a similar form named from the same geographical region, *P. essingtonensis* Sowerby,[14] and as the distinction seems merely one of habit, Sowerby's name is preferable. The New South Wales specimens vary in the number of ribs and shape and are imbricately sculptured on the main ribs, the wide interstices being radially striate, and all being smaller, may be named subspecifically as above.

Hab.—Sydney Harbour, New South Wales.

Varotoga gen. nov.

Hedley figured the animal of his *Solecardia cryptozoica,*[15] and this species is named as type of *Varotoga*, as *Solecardia* was simply a general name for any glassy oval shell. It has been long recognized that the shells differed in texture and teeth characters, but no attempt has been made to straighten matters up. Three different animals were observed among the specimens at Low Island, and similar discrepancy at once appears in connection with the two Sydney species. Hedley's species lives in the muddy inland waters, while *Scintilla strangei* Deshayes[16] lives under stones on the open sea-coast reefs. The animal of this species differs from that of *Varotoga* in lacking pustules, being translucent and milky white, and in the development of siphonal processes at each end. This animal will be figured later, but here the new genus *Lactemiles* is introduced for it alone.

Petricola rubiginosa (A. Adams and Angas).

A beautiful shell brought in by Captain Comtesse puzzled me and I was astonished to find it included in the New South Wales list under the above genus. I had been working at the coral-living species of *Petricola* from Queensland, and this species did not recall them. *Petricola* was introduced by Lamarck[17] with three species, but none specifically described, the first being *P. sulcata*, a new name for *Venus lithophaga* Retz, the second *P. costata*, a new name for *Venus lapicida,* and the third *P. striata*, a *nomen nudum*.

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[13] Finlay.—Trans. New Zeal. Inst., lvii, 1926 (1927), p. 527.
[14] Sowerby.—Conch. Icon (Reeve), xix, Oct., 1873, pl. iii, sp. and fig. 8.
[15] Hedley.—Proc. Linn. Soc. N.S.W., xli, April 4, 1917, p. 684, pl. xlvi, fig. 1; pl. li, fig. 40.
[16] Deshayes.—Proc. Zool. Soc. (Lond.), 1855, p. 181; 1856. Hedley.—Proc. Linn. Soc. N.S.W., xxxviii, Nov., 1913, p. 268, pl. xvi, figs. 16-19.
[17] Lamarck.—Système des Animaux sans Vertèbres, 1801, p. 121.

Gray selected the first named[18] and this species is not like the Sydney shell. It may here be mentioned that two earlier type designators have been discovered and utilized. Children[19] *anonymously* described and figured the Lamarckian Genera of Shells and named types, but these were merely the first species named in the "Histoire des Animaux sans Vertèbres," and can only be utilized in connection with Lamarckian genera as of that introduction. Thus in the present case *striata* is named as type, but we have seen that at the first introduction the name was not validly proposed. Anton[20] has likewise been brought into use and there seems to be no bar to consideration of his designations, but in this case also he selected *striata*, leaving Gray to make a valid designation.

Choristodon was proposed by Jonas[21] for a new species, *C. typicum*, boring into rocks at the Island of St. Thomas, and this has been determined as equal to *V. lithophaga* Retz, and therefore *Choristodon* becomes an absolute synonym of *Petricola* as typified by Gray.

Naranio was added by Gray[22] for the *lapicida* series, and this generic name can be used for the coral-boring Queensland species, but cannot be adopted for the Sydney shell, *rubiginosa*, which lives in mud, and is here made the type of a new genus, *Velargilla*.

Quadrans parvitas sp. nov.

(Pl. xxii, figs. 10-12.)

When on the dredge and also at the dump I collected a quantity of shell fragments from which to pick out smaller shells than would interest Captain Comtesse and Mr. Nash. The latter filled a sack later and sent it me and many small and remarkable shells have been found in it. A curious little Tellinid recalling the tropical *Quadrans gargadia* Linné was one of these, and, on studying Bertin's Monograph of the Tellinidæ,[23] a very similar shell was found described from New Caledonia as *Tellina (Quadrans) minor*. Discussion whether the Sydney shell was identical or not is unnecessary, as Bertin's name had been anticipated by Jeffreys.[24]

Compared with Bertin's figure, the Sydney shell has the anterior end less produced and is a little deeper, the striation more marked, and the hinge is more compressed.

Cantharidus eximius (Perry).

Under this specific name Hedley confused two species, a large one and a small one. A reference is given to a note by himself[25] wherein he placed *Elenchus ocellatus* Gould, from a photograph of the type, as the young of the above-named species. Gould's species was collected by W. Stimpson in Sydney Harbour, and is quite valid, being easily separated by its more elongate shape, its coloration, its size and the more prominent tooth on the columella. At the same place Hedley

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[18] Gray.—Proc. Zool. Soc. (Lond.), 1847, p. 184.
[19] Children.—Quarterly Journal Phil. Sci., xiv-xv, 1822-1824.
[20] Anton.—Verz. Conch., 1838, p. 2.
[21] Jonas.—Zeit. für Malak. (Menke), 1844, p. 185
[22] Gray.—Ann. Mag. Nat. Hist., (2), xi, 1853, p. 38.
[23] Bertin.—Nouv. Archiv. Mus. Paris, (2), i, 1878, p. 267, pl. ix, fig. 5, *a*, *b*, *c*.
[24] Jeffreys.—Brit. Conch., ii, 1863, p. 376.
[25] Hedley.—Proc. Linn. Soc. N.S.W., xxxiii, 1908, p. 465.

pointed out that Swainson had figured *C. eximius*,[26] but that Swainson's name *Elenchus splendidulus* appeared to him to be referable to the New Zealand shell. This conclusion cannot be upheld as Swainson's description (p. 352, footnote) reads: "Small, entirely fawn colour, or light brown; aperture of the most brilliant purple and emerald green. Australia." As Swainson had Tasmanian shells, I designate Tasmania as type locality of *E. splendidulus*, and it thus becomes an absolute synonym of Perry's *eximius*, whose figure is very like Swainson's. I refer both *eximius* and *ocellatus* to *Phasianotrochus*.

Thalotia comtessei sp. nov.

(Plate xxiii, fig. 8.)

Hedley included *Calliostoma decoratum* in the New South Wales list, citing many synonyms. I pointed out that[27] this choice was invalid and proffered one of the synonyms, selecting *Thalotia* as a better generic refuge than *Calliostoma*. It now appears that my name selection must be abandoned and therefore I have to describe as a new species this common Sydney shell. It is dedicated to Captain Comtesse, whose researches are worthy of daily recognition such as is offered by the shell under consideration.

Shell conical, variously coloured, straight-sided, base a little convex. Adult whorls eight, protoconch one and a half smooth, succeeding sculpture consisting of five concentric beaded linæ, the lowest more pronounced; interstitial threads are developed with age; eight similar liræ on base. Columella curved, ending in a slight notch; outer lip thin. Colour of normal specimen brownish red, more or less flamed with darker. Height 21 mm., breadth 14 mm.

Type from Sydney Harbour, New South Wales.

Before leaving the Trochoids a very beautiful shell trawled by Captain K. Möller off Disaster Bay in about 50 fathoms may be described as *Fautor excultus* sp. nov. (Pl. xxii, fig. 15). It is a bright fawn, marked on prominent liræ with red dashes. The whorls are seven, an apical one slightly exsert, rounded, sutures impressed, imperforate. The sculpture consists of fine rounded liræ with threads between, there being no longitudinal sculpture. The liræ number about twenty on the penultimate whorl, half the number being smaller than the other half, and only half a dozen prominent. The base is similarly sculptured. Columella slightly arcuate, inner lip reflected over umbilical depression, which is white, and semi-noduled anteriorly; aperture slightly rhomboid, outer lip simple. Length 15 mm., breadth 12 mm.

Bembicium nodulosum (Gray).

Through the influence of authorities not conversant with the life histories of the molluscs whose shells they are studying, only one species of *Bembicium* appears on the New South Wales list. But the youngest collector differentiates two, and these are found to have different habitats, one living on the open shore and entering the harbours, while the other lives among the mangroves and in less saline water. Their form is very distinct when series are studied, the former being comparatively smooth, a flat broad cone in shape, the latter being strongly noduled and a long elevated cone. These range along the whole coast, but

[26] Swainson.—Treatise on Malacology, May, 1840, p. 220, fig. 40.
[27] Iredale.—Proc. Linn. Soc. N.S.W., xlix, 1924, p. 229.

geographic variation has entailed much of the confusion. While the open coast form can bear the name *B. melanostoma* Gmelin, based on a shell collected by Captain Cook's party at Botany Bay, the only name available for the nodulose form appears to be Gray's. A photograph has recently appeared in the *Australian Museum Magazine.*[28]

Carswellena gen. nov.

Many large specimens of *Turbo militaris* Reeve in bad condition have been collected by Captain Comtesse and E. F. Nash, and when the former had secured a few of *Turbo exquisitus* Angas, the latter sorted out quite a large series which showed this little species to uncoil so as to show sometimes a false umbilicus. This feature seemed to ally it to *Senectus*, which it resembles in shell character, but the operculum as figured by Hedley[29] indicates that the relationship may be with *T. stamineus*. As the alliance can not be close, the new genus *Carswellena* is introduced for it alone. As 441*a* Hedley allowed *Turbo petholatus* Linné, but this must be entirely rejected, as the record of Angas obviously referred to the species now recognized as *militaris* Reeve, some northern specimens of the tropical *petholatus* even showing a similar coloration. Further, the very large size of the *militaris* suggests close relationship to the monster South Australian *jourdaini*, an unexpected conclusion. Again, the New South Wales shell listed as *Turbo undulatus* Martyn must bear the name *Lunella anguis*, after an excellent figure also by Martyn but correctly named by Gmelin.

Laciniorbis morti sp. nov.

(Pl. xxii, figs. 4-6.)

Fifty years ago Martens described *Adeorbis fimbriatus* from McCluer Bay, New Guinea, from a depth of 732 metres (about 400 fathoms). Twenty-six years later[30] he proposed a new genus *Laciniorbis* for this species, giving excellent figures.

A very beautiful shell was dredged in shallow water off Murray Island ten years later by Hedley and was left unnamed, its exact systematic position being doubtful and Martens' figures being forgotten.

Mr. H. S. Mort picked out of the dredgings a smaller shell recalling the Torres Strait specimen, and a stray reference to Martens' paper in another connection recognized the generic relationship. Later Mr. Mort found another specimen and I also recovered one, and comparison shows constant distinction from the two tropical species. The Torres Strait shell, which is here figured and named *Laciniorbis hedleyi* (Pl. xxii, figs. 1-3), has a more depressed spire than the New Guinea form and has the basal sculpture less pronounced. On the other hand, the Sydney shells, here named after Mr. Mort, are smaller, with more pronounced sculpture above and equally as strong below.

Shell discoidal, minute, openly coiled, sutures subcanaliculate, the periphery strongly keeled, the spire depressed. Colour white. The first whorl is minute and is succeeded by three rapidly increasing whorls on the same plane; sculpture consists of fine spiral concentric liræ increasing from five to ten to twelve,

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[28] Aust. Mus. Mag., III, 1929, p. 344.
[29] Hedley.—Proc. Linn. Soc. N.S.W., xxvi, 1902, p. 701, pl. 34, fig. 7.
[30] Martens.—Arch. f. Nat. (Wiegmann), lxiii, 1, 12, Nov., 1897, p. 175.

interstices very finely threaded. At the periphery a fine lamina is produced from a keel, the base being slightly convex and with similar spiral liræ, which, however, are more distant and number about eight, which persist into the open umbilicus. The mouth is wider than deep, the edges thin, the columella short and curved and a little reflected, the inner lip crossing the body whorl as a glaze and almost forming a free aperture. Height 3 mm., breadth 10 mm.

Type from Sydney Harbour.

The Torres Strait shell measures 18 mm. in breadth and 4·5 mm. in height.

Theodoxis souverbianus (Gassies).

Under this name Hedley included the species named *Neritina pulcherrima* by Angas, who had described it from the "Sow and Pigs" reef, Sydney Harbour.[31] At the same time Angas recorded *Neritina rangiana* Recluz from the same locality which is missing from our list without explanation.

Hedley appears to have regarded the two records as referable to the same thing, but two species do occur here, many specimens being picked out of the Harbour dredgings by Comtesse, Nash, Mort, Dingeldei, and myself. Baker has recently monographed the group[32] and has separated a subfamily Smaragdiinæ for the genus *Smaragdia*, introducing a subgenus *Smaragdella* for the *souverbiana* series. This name must be used and Angas' specific name reinstated. I have not yet located the second species under Baker's scheme, so for the present I am including it under the name *Neritina rangiana* auct. Its correct name will be recorded very shortly.

Phenacolepas mirabilis Sowerby.

Mr. H. S. Mort collected (October, 1929) a broken but fine specimen of this handsome shell at Yamba, mouth of the Clarence River, northern New South Wales, a new record for the State. It is not uncommon, generally broken, however, at Caloundra, south Queensland, whence the type was probably collected, Sowerby simply giving "Australia."[33]

For the present this species will represent *Phenacolepas* in our fauna, as the species previously referred has been transferred to *Cinnalepeta* Iredale.[34]

Opposirius idoneus gen. et sp. nov.

(Pl. xxii, fig. 7.)

An elongated representative of one of the series variously regarded as *Separatista*, *Lippistes*, *Trichotropis* and *Sirius*, which must be contrasted with *Dolichosirius cupiens* described below.

Shell elongate, last whorl equal to spire, whorls rounded, sutures deep. Colour of dead shell fawn. Two glassy, erect, apical whorls are succeeded by five adult sculptured whorls; on each whorl two main spiral liræ with one fainter above and a weaker one below forming a sutural bead. On the last whorl there are five distant raised spiral liræ, not nodulose, but wavy; between these are faint threads, which are overriden by fine threads following growth lines, so that a very weak cancellation can be seen. Columella a little sinuate, inner lip thin, a little reflected,

[31] Angas.—Proc. Zool. Soc. (Lond.), 1871, p. 19, pl. i, fig. 25.
[32] Baker.—Proc. Acad. Nat. Sci. Philad., lxxv, May 15, 1923, p. 117 et seq.
[33] Sowerby.—Proc. Malac. Soc. (Lond.), ix, March, 1910, p. 66, fig. in text.
[34] Iredale.—Mem. Q'land Mus., ix, June 29, 1929, p. 274.

almost hiding an umbilical chink guarded by a fairly stout funicle; outer lip thin and sharp, canal very short and open. Length 13 mm., breadth 6 mm.

Hab.—Sydney Harbour, picked out of dredgings by Mr. E. F. Nash.

Dolichosirius cupiens gen. et sp. nov.

(Pl. xxii, fig. 9.)

Shell elongately trochiform, whorls eight, apex missing, whorls very rounded, shoulders tabulate, sutures very deep. Colour brown marked with red. Sculpture: penultimate whorl with rounded periphery carrying five spiral rounded liræ, there being three spiral threads on shoulder; on the last whorl minor threads intervene, while on the base there are five major and five minor spirals. The interstices are crossed by slanting longitudinal threads, comparatively widely spaced and stout.

Columella almost straight, sharply truncate, inner lip reflected over narrow umbilical chink: outer lip thin, aperture almost circular, canal very narrow. Length 11 mm., breadth 8 mm.

Hab.—Sydney Harbour, picked out of dredgings by Mr. H. S. Mort.

This and the preceding do not appear to be closely related, yet each might have been referred to the same group had either been studied alone. It is therefore suggested that a family Siriidæ be used for these until the animals are studied; they do not appear to have anything whatever to do with *Lippistes* or *Trichotropis.*

Family STROMBIDÆ.

At Michaelmas Cay, north Queensland, many species of Strombs were collected, and a review was undertaken. This proved of the greatest interest and was in progress when the opportunity of again studying them at Low Isles occurred; a later trip to Three Isles assisted their elucidation, and then Mr. Melbourne Ward collected many specimens at Torres Strait and the Capricorn Group. The "Triton" dredgings revealed a similar fauna in Sydney Harbour, and the unexpectedness of this discovery has been intensified by the recognition of a very distinct species. The Capricorn Group will be personally visited soon and further study will be made on points at present under consideration.

In the meanwhile, in order to record the strange Sydney finds, the following notes are published, anticipatory to the monographic account.

The "*auris-dianæ*" group comprises a few species which have been continually confused by "cabinet-workers," yet which are very distinct in the field. A few group names have been utilized, and I find that *Euprotomus* is the correct one, a curious conclusion inasmuch as this generic name has been generally used in another connection. On the Queensland mainland a species is found which also occurred at Low Island; this has been known as *melanostomus* Swainson, but may have to bear the specific name *aratrum* Bolten. On the Great Barrier Reef two species occur together, one rough and one smooth, and these have been called *auris-dianæ* Linné, most authorities differing as to their distinction and also as to their nomination if distinct. In Australian waters two very clearly distinct species are found, the rough one being the true *auris-dianæ* of Linné, the smooth one being called *bulla* Bolten. None of these three has occurred as yet in Sydney Harbour but a beautiful new species, here named *Euprotomus donnellyi*, has been discovered instead. Fragments were first found and these were so like the

Polynesian species known as "*aratrum* Martyn" that they were put on one side until better material was secured, although the existence of a species of *Euprotomus* in this locality was of such interest that it deserved record even on imperfect material. A fine damaged specimen was then found and it did not show great distinction from the Polynesian species, but Donnelly, second engineer at Dundas, picked out a perfect specimen, which is named after him and which is one of the most remarkable finds yet made. It differs from all the other members of the genus *Euprotomus* in lacking the development of the lip finger.

Captain Comtesse then produced another species of Stromb which he had separated from *campbelli*, also found in the Harbour, though previously known only from the North Coast. This proved to be *vittatus*, and for this well-known group I provide the name *Doxander*, *vittatus* being named as type.

Then, not to be outdone, Mr. E. F. Nash found another little species, *pulchellus* Reeve (Pl. xxiii, fig. 12), while looking for small Strombs in the hope of re-finding *flammeum* Link, as already noted. The latter duly turned up, but, sorting out small siftings, I secured another little species, which is here called *Canarium otiolum*, sp. nov.

So far, then, we have found in Sydney Harbour the following Strombs:

Conomurex luhuanus Linné.
Canarium flammeum Link.
urceus Linné.
otiolum Iredale.
Labiostrombus dilatatus Swainson.
Doxander vittatus Gmelin.
campbelli Griffith and Pidgeon.
Dolomena pulchella Reeve.
Euprotomus donnellyi Iredale.

On the New South Wales list is *Strombus elegans* Sowerby, recorded by Angas, which has not yet turned up.

Canarium otiolum (Pl. xxiii, fig. 6) is small, spire exsert, varicose, outer lip a little expanded, sinuate. Colour of dead shell cream, variously banded with pale brown. Six adult whorls succeed a smooth, bulbous, mucronately tipped protoconch; the adult whorls are regularly four-varicose, the last whorl showing none but the outer lip thickened and a little varicose. Internally this is finely ridged, the inner lip smooth. Fourteen longitudinals appear on the shoulder of the last whorl but soon become obsolete on the body; a small sutural roll succeeds, the sutures followed by concentric ridges which are undefined on the face of the body whorl but become more pronounced towards the base. On the penultimate whorl two or three longitudinals appear irregularly between each varix, the concentric liræ less pronounced and becoming still less as we approach the apex. Length 22 mm., breadth 10 mm.

Type from Sydney Harbour, N.S.W.

This species belongs to the "*floridus*" (= *flammeum*) series but has a more developed spire, more definitely varicose, and is smaller in size.

Euprotomus donnellyi (Pl. xxiii, fig. 19) is large with expanded outer lip with no finger. Coloration of dead shells, fawn marbled with white, the aperture white, the inner glaze covering the body whorl, a brown patch towards the posterior end of the aperture, inside of outer lip strongly ridged and brownish. Sculpture: Earlier whorls with a median keel upon which pointed nodules develop, which

become more distantly placed as the shell grows, six or seven on the body whorl, although there are twelve on the penultimate and fourteen on the antepenultimate. Above the shoulder close threads persist, which weaken and are obsolete on the body whorl; no sutural roll. Outer lip expanded and running up two full whorls but producing no finger. Canal strongly recurved backwards. Length 75 mm., breadth 45 mm.

Type from Sydney Harbour, New South Wales.

Distorsio francesae sp. nov.

(Plate xxiii, fig. 2.)

I figured this species under the name *Distorsio reticulata* Bolten (from the Island of Hitoe, one of the Moluccas), but good specimens show valid differences, and these are confirmed by the collection of a beautiful living shell by Messrs. Melbourne Ward and W. Boardman at North-west Island, Capricorn Group. This specimen shows a periostracum of finely packed threads running along the spiral, and longitudinal sculpture with long prominent processes throughout along the strong cross ribs; the mouth in this living shell is very beautifully coloured rose-flesh. The Philippine shell has the mouth yellow brown and a longer canal and the teeth, though very similarly placed, also show variation. Another photograph is here presented from a fine specimen collected by Captain Comtesse, collected in Sydney Harbour, and is named in honour of Mrs. Comtesse.

Family BURSIDÆ.

Although four species referable to this family were on the New South Wales list, none had been met with by Hedley during his thirty years of searching. The four names read *Gyrineum pusillum* Broderip, *Bursa bufo* Bolten, *B. granifera* Lamarck and *B. mammata* Bolten. Type designations by Children and Anton having now to be taken into consideration, Dall's results,[35] upon which all recent work has been based, must be reviewed. Children's selection of the type of *Ranella* is *gigantea*, which will thus replace *Eugyrina* Dall for the European species, a favourable result. Rovereto[36] designated *spinosa* as type of *Gyrineum* Link,[37] thus leaving *Apollon* Montfort[38] for the series of *gyrinus*. It may be noted that Dall,[39] confusing in his mind *Gyrineum* and *Eugyrina*, proposed a new name *Gyrinella* for the small species *pusilla*.

Of the three species classed under *Bursa* by Hedley, the last-named *mammata* Bolten will retain that name, the first-named *bufo* will be transferred to *Tutufa*, and the other one, *granifera* Lamarck, apparently equivalent to *granularis* Bolten and *jabick* Bolten, the latter having priority, is here made the type of a new genus *Dulcerana*. Of these four *mammata* Bolten has not yet been met with, but specimens of the other three have been found, and yet another, a beautiful little specimen of the "*crumena*" series. Lamarck appears to have intended *Ranella crumena* as a new name for *Murex rana* Linné to avoid tautonymy. According to Reeve's citations, the Philippine species known as *crumena* will bear the name

[35] Dall.—Smithson Miscell. Coll., Qtly. Issue, xlvii, 1904, pp. 114-144.
[36] Rovereto.—Atti Soc. Ligustica, x, 1899 (ext. p. 6).
[37] Link.—Beschr. Rostock Samml., 1807, p. 123.
[38] Montfort.—Conch. Syst., ii, 1810, p. 571.
[39] Dall.—Proc. Biol. Soc. Wash., xxxvii, p. 89, Feb. 21, 1924.

cavitensis,[40] a MS. name of Beck cited by Reeve in connection with the figure. Reeve gives a good figure[41] resembling our species, which is here called *Gyrineum pacator* sp. nov.

Gyrineum pacator sp. nov.

(Pl. xxiii, fig. 3.)

Shell small, fusiform, biconical, varicose, varices evenly set up each side.

Adult whorls five and a half, with a three and a half whorled smooth protoconch. The protoconch is followed by an adult whorl, five cingulate, the cingular almost beaded and very finely striate between, the middle thread strongest; this develops into a keel, which later becomes nodulous, the nodules flattened sideways. The last whorl shows three nodules in front, four at back, one nearest preceding varix largest and decreasing towards aperture; below a less marked keel also occurs, the nodules small and variable in size. The primary keel ends in a point at the varix, which is thickened and rolled and succeeded by a thin lip edge from which the posterior canal is produced. The interior of the outer lip is beautifully denticulate, the canal short, open, but narrow, the columella curved and closely wrinkled, the wrinkling persisting across the inner lip and reaching to the outer lip at the posterior canal; an umbilical depression is present and there the shell is expanded a little, forming a pseudo-funicular rib. Colour of the dead shell a beautiful fawn. Length 39 mm., breadth 26 mm.

Collected by Mr. E. F. Nash from Sydney Harbour dredgings.

The name of the form for which Hedley suggested *Bursa bufo* Bolton is difficult to determine at present, but the best selection seems to be *Tutufa lissostoma* Smith[42] (Pl. xxiii, fig. 5).

It may be here recorded that a shell belonging to a different group of Frog Shells shows a very similar nodule development, *viz.*, *Ranella thersites* Redfield,[43] which was erroneously referred to *californica* by Tryon. It was supposed to come from the Pacific Ocean and a very similar shell is in the Australian Museum from New Britain; it is referable to the genus *Bursa*.

Sydney Cassids.

Very recently I reviewed the Helmet Shells of Australia[44] and listed a number of species from northern New South Wales. It is possible that all will yet turn up in Sydney Harbour, as *Semicassis diuturna* Ired. (Pl. xxiii, fig. 21), is fairly common. *Xenogalea angasi* Ired. occurs mostly broken, as does the very rare *X. sophia* Brazier; a dwarf form of *X. thomsoni* Brazier hereafter named is not uncommon, while a beautiful new species is named *Xenogalea nashi* after the finder, Mr. E. F. Nash, who has displayed so much energy and keensightedness in picking out novelties (Pl. xxiii, fig. 18).

X. nashi is of medium size, oval, spire short, whorls convex, sutures impressed.

Coloration: Upon the white background of the last whorl appear five concentric rows of separate rhomboidal patches of colour, the first row below the shoulder passing along the middle of the penultimate whorl, the lowest a short row just

[40] Reeve.—Conch. Icon., ii, July, 1844, pl. iv, fig. 17, var. *β*, fig. *a*.
[41] Reeve.—Conch. Icon., ii, July, 1844, pl. iii, fig. 15.
[42] Smith.—Journn. Conch. (Leeds), xiv, Oct., 1914, p. 230, pl. 4, fig. 3.
[43] Redfield.—Ann. Lyc. New York, iv, Feb., 1846.
[44] Iredale.—Rec. Austr. Mus., xv, 1927, pp. 321-354.

above the funicular canal. Colour pale orange. Sculpture (apical whorls missing) begins as five or six distinct spiral liræ overrun by minute radial threads. After a couple of whorls the radials become obsolete and the spirals become wider spaced and less defined but continue to the last whorl, where they run along the shoulder as weak threads; the body whorl is thus smooth medially but shows a curious malleation, while basally half a dozen faint grooves reappear.

Aperture reverse ear-shaped, the outer edge rolled back and denticulate within, the teeth showing only on the inner edge.

Columella sinuate, strongly lirate, about nine distinct liræ being counted running well inside the aperture but fading externally where the columella finishes as a sinuate thick edge. Canal short, recurved, with a deep gutter behind, a narrow false umbilicus, and the canal itself is slightly perforate, the tongue smooth. Length 59 mm., breadth 43 mm.

Xenogalea thomsoni palinodia subsp. nov. (Pl. xxiii, fig. 20) is provided for the small stout shells which are much more solid, more strongly sculptured, especially longitudinally, and with the columella strongly wrinkled. The type is rather like this form but is thin in texture, and develops into a large obsoletely sculptured form commonly trawled off the coast of New South Wales. Length 44 mm., breadth 35 mm.

Family TONNIDÆ.

This family has continued to provide surprises, for when Hedley[45] comparatively recently revised the Australian species, only two species were on the New South Wales list. Hedley rejected one, but added two others, thus allowing a total of three. I reinstated the rejected one and added another.[46] It must be here mentioned that at the foot of page 345 a description follows the references to *Dolium rufum* and *Buccinum pomum*. This has nothing to do with these species, but belongs to *Vicimitra prosphora* of page 343; the sheets were disarranged after the pages were passed for press.

More specimens of *Quimalea pomum* have been secured by Captain Comtesse and Mr. E. F. Nash, and these are all stunted with the mouth more open and developing an extraordinary varix. This form is here designated as *Quimalea pomum macgregori* subsp. n. (Pl. xxiii, fig. 22) in order to record the environmental variation of the tropical forms well emphasized in this case.

Three more species have been collected and reference to Hedley's Revision shows his names to read *Tonna costata* Menke, *Tonna parvula* Tapp-Canefri (Pl. xxiii, fig. 24) and *Tonna canaliculata* Linné. The first named was represented from Australia by four records from Queensland and one from West Australia, the second by a dubious record by Shirley from north Queensland, and the third by one record from Queensland and one from West Australia. The occurrence of all three in Sydney Harbour is remarkable and suggests their wide range in suitable localities. I recorded a dwarf of *T. tetracotula* Hedley (Pl. xxiii, fig. 26), but more specimens suggest its distinction subspecifically as a degenerate form.

For the shell named *costata* Menke there is an earlier name *allium* of Dillwyn[47] (Pl. xxiii, fig. 23), who introduced this from Solander's MS. for his variety β of Linné's *B. dolium*, citing Martini iv, p. 396, t. 117, f. 1072, and t. 118, f. 1082, from

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[45] Hedley.—Rec. Austr. Mus., xii, Oct. 2, 1919, pp. 329-336.
[46] Iredale.—Austr. Zool., v, 1929, p. 345.
[47] Dillwyn.—Descr. Cat. Rec. Shells, 1817, p. 585.

Tranquebar. The small species Hedley recorded as *T. cumingii* is never so globose as that species and is nearer *D. testardi* Montrouzier, which Hedley synonymized. It is narrower and stouter, with the ribs 20-22 on last whorl, strong inner lip glaze, and is here named *Parvitonna perselecta* gen. et sp. nov. (Pl. xxiii, fig. 17), the small Tun-shels obviously needing separation from the large typical ones.

Ficus margaretæ sp. nov.

(Pl. xxiii, fig. 4.)

Sycotypus reticulatus was recorded by Angas[48] from the mouth of the Macleay River, collected by Brazier. Hedley[49] emended the name to *Ficus communis* Bolten, practically the same form as Angas listed, the name being selected on account of priority. Broken specimens from the Richmond River beaches suggested differentiation, and broken pieces collected by Captain Comtesse confirmed this. A complete shell secured by Mr. E. F. Nash allows the description of the southern species, which is more like the West Australian species known as *tessellata* Kobelt but which many years before Kobelt's time had been called *Pyrula eospila* by Peron[50] from Ile Depuch, West Australia.

It is just as delicately sculptured with similar coloration to, but much narrower than, the common "Fig" called *reticulata*, a little broader than *eospila*.

Sinum spp.

Many specimens of the shells listed by Hedley under the genus *Sinum* as *coarctatum* Reeve, *nitidum* Reeve, and *planulatum* Rechz, occurred in the Harbour dredgings. Obviously the first and last were not congeneric, and, as previously noted, every worker seems to have arrived at the same conclusion without rectifying the error.

Before dealing with these I may record that the next genus and species are altogether out of place. The shell named *Amauropsis morchi* by A. Adams and Angas is there classed under *Pellilitorina* in the family Naticidæ. I collected a specimen depositing eggs on a boulder at Long Reef and it is obviously not Naticoid but had better be placed in the family Littorinidæ under the new generic name *Problitora*.

I showed that the name *Sinum planulatum* Recluz could not be maintained,[51] so that the local shell is here named *Ectosinum pauloconvexum* sp. nov. (Pl. xxiii, fig. 16).

The other species is globose, openly umbilicate, and disagrees altogether with the preceding, and is here named *Pervisinum dingeldeii* n. sp. (Pl. xxiii, fig. 15). It was determined as *S. nitidum* Reeve and also appears in our list as *S. coarctatum* Reeve, but these records appear to refer to the same shells on account of the variation seen. In all Naticoids, on account of the great development of the animal, an appreciable amount of variation is observed, and consequently Tryon lumped many distinct species through lack of specimens and confusion of localities. This species is more globose than any other described species and thus shows a larger umbilicus. It may be related to *Eunaticina* Fischer, but he figures an acuminate

[48] Angas.—Proc. Zool. Soc. (Lond.), 1877, p. 182.
[49] Hedley.—Proc. Linn. Soc. N.S.W., xxxiii, Nov. 20, 1908, p. 461.
[50] Peron.—Voy. Terre Austral., i, 1807, p. 132.
[51] Iredale.—Proc. Linn. Soc N.S.W., xlix, 1924, p. 254.

shell with a small umbilicus and a sinuate columella. In the present case the umbilicus is large, the columella straight, and the operculum unknown.

Shell globose, thin, widely umbilicate, whorls four, rapidly increasing. Colour dead white. Sculpture of about twelve flat topped liræ with very narrow interstices on the penultimate whorl; these spread out so that on the last whorl they are separated by interstices wider than the ribs, upon which fine threads develop. Fine radial threads override this and alone persist into the umbilical cavity, where the spirals become obsolete. The mouth is very broad, the outer edge forming almost a complete semicircle. The columella is straight, and, were it not for its connecting with the body whorl and thence linking up with the posterior edge of the outer lip by means of a callus, it would almost make a diameter. Length 20 mm., breadth 19 mm.

The type is a beautiful specimen collected by Mr. W. Dingeldei from the Harbour dredgings, and is named in appreciation of his enthusiasm. *Ectosinum pauloconvexum* is small, flattened, impervious, much broader than high, whorls two, succeeding a flattened, glassy, two-whorled protoconch. This smooth protoconch appears quite different from the minute nucleus of *Pervisinum*, which is not definitely separated, while this shows up at sight. The succeeding sculpture consists of fine spirals crossed by fine growth lines, which do not cancellate the surface.

The mouth is strongly patulous, the spire very short, while the columella forms a long sweeping arc, reflected posteriorly and joining the outer lip with a small callus. Height 10 mm., breadth 14 mm.

Not uncommon among the dredgings in Sydney Harbour.

Gennæosinum intercisum sp. nov.

(Pl. xxiii, figs. 13, 14.)

I introduced the genus *Gennœosinum*[52] for a strange Naticoid from Michaelmas Cay, north Queensland, and to my surprise Captain Comtesse brought in an allied species from Sydney Harbour. I later found a second specimen which differed slightly.

Shell small, globose, spire a little elevated though still small, sculpture of flattened threads closely packed with an overriding series of slight growth lines. Colour dead white. Umbilical funicle less pronounced than in the type. Height 13 mm., breadth 13 mm.

The sculpture is much finer and the shell is smaller than the typical species. The second specimen is smaller still, almost smooth, the spirals showing only on the whorls below the sutures, which are a little more canaliculate. This may represent still another species or be merely an aberration.

Hab.—Sydney Harbour, New South Wales.

Family CYPRÆIDÆ.

Under this family name Hedley included the Cowries, Egg Shells and others, but Schilder has separated many families which are here recognized. Many genera were also listed and I have given a brief account in connection with the Queensland forms[53] last year. The New South Wales forms are

[52] Iredale.—Mem. Q'land Mus., ix, June 29, 1929, p. 279, pl. xxxi, fig. 12.
[53] Iredale.—Mem. Q'land Mus., x, Aug. 28, 1930, pp. 80-86.

here revised as much material is now available through the energy of Messrs. Comtesse and Nash, to whom these beautiful shells appealed. Their collections from the dredged material have revealed an extensive Cowry fauna with a facies quite distinct from the present series living on the rocks adjacent to the area dredged. Schilder omitted to take into consideration Jousseaume's first essay,[84] so I cite the names here: *Bernaya* (type not stated), *Gisortia* (no type selected), *Mandolina* ex Bayle MS. (haplotype, *gibbosa* Born), *Zoila* (no type named), *Maurina* (haplotype, *mauritiana* L.), *Etrona* (no type selected), *Umbilia* (haplotype, *umbilicata* Sow.), *Vulgusella* (no type given), *Arabica* (tautotype, *arabica* L.), *Cypræa* (for the *cervus* group), *Porcellana* ex Klein (for the *argus* series), *Luria* (no type named), *Zonatia* (tautotype, *zonata* Chemn.), *Adusta* (tautotype, *adusta* Chem.), *Stolida* (tautotype, *stolida* Lin.), *Criraria* (tautotype, *criraria* L.), *Bastorotia* ex Bayle MS. (no type selected), *Ponda* (no type given), *Staphylæa*, p. 415 (tautotype, *staphylæa* L.), *Tesselata* (tautotype, *tesselata* Sow.), *Ipsa* (haplotype, *childreni* Gray), *Nuclearia* (no type named), *Jenneria*, *Pusula*, *Triviella*, *Niveria*, *Trivirostra* (no types named, but haplotype of *Niveria*, *nivea* Gray). In the later essay in the Rev. Zool., quoted by Schilder, types were designated, but the spelling of some names altered, thus *Maurina* became *Mauxiena*, *Etrona* was written *Trona*, *Zonatia* was spelt *Zonaria*, *Criraria*, an obvious typographical error, was corrected to *Cribraria*, and *Bastorotia* to *Basterotia*, *Tesselata* to *Tessellata*. The arrangement of Hedley's *Cypreæ* under the revised nomenclature would read thus:

No. 706.	*C. angustata comptoni*	undetermined.	
No. 706*a*.	*C. angustata piperata*	should be	*Notocypræa piperita* Gray.
No. 707.	*C. annulus*	„ „	*Monetaria annulus* Linné.
No. 708.	*C. arabica*	„ „	*Arabica arabica* Linné.
No. 709.	*C. armenaiaca*	„ „	*Umbilia hesitata* Iredale.
No. 710.	*C. asellus*	„ „	*Evenaria asellus* Linné.
No. 711.	*C. caputserpentis*	„ „	*Ravitrona caputserpentis* Linné.
No. 711*a*.	*C. caputserpentis caputanguis*	„ „	rejected.
No. 712.	*C. carneola*	„ „	*Lyncina carneola* Linné.
No. 713.	*C. caurica*	„ „	*Erronea caurica* Linné.
No. 714.	*C. clandestina*	„ „	*Palmadusta clandestina* Linné.
No. 715.	*C. erosa*	„ „	*Erosaria erosa* Linné.
No. 716.	*C. errones*	„ „	*Erronea errones* Linné.
No. 716*a*.	*C. errones cruenta*	„ „	*Erronea chinensis* Gmelin.
No. 717.	*C. felina*	„ „	*Melicerona listeri* Gray.
No. 718.	*C. fimbriata*	„ „	*Paulonaria fimbriata* Gmelin.
No. 718*a*.	*C. fimbriata notata*	„ „	*Paulonaria macula* Angas.
No. 719.	*C. flaveola*	„ „	*Erosaria nashi* Iredale.
No. 720.	*C. helvola*	„ „	*Ravitrona helvola* Linné.
No. 721.	*C. hirundo*	„ „	*Evenaria hirundo* Linné.
No. 722.	*C. isabella*	„ „	*Basilitrona isabella* Linné.
No. 723.	*C. limacina*	„ „	*Staphylæa limacina* Lam.
No. 724.	*C. lutea*	„ „	*Palmadusta humphreysii* Gray.
No. 725.	*C. lynx*	„ „	*Lyncina vanelli* Linné.
No. 726.	*C. miliaris*	„ „	*Erosaria miliaris* Linné.

[84] Jousseaume.—"Le Naturaliste," 6, An, Feb. 15, 1884, pp. 414-5.

No. 727.	*C. moneta*	should be *Monetaria moneta* Linné.
No. 728.	*C. poraria*	„ „ *Ravitrona poraria* Linné.
No. 729.	*C. punctata*	„ „ *Evenaria punctata* Linné.
No. 730.	*C. tabescens*	„ „ *Talostolida teres* Gmelin.
No. 731.	*C. scurra*	„ „ *Arabica scurra* Gmelin.
No. 732.	*C. subviridis*	„ „ *Gratiadusta vaticina* Iredale.
No. 733.	*C. vitellus*	„ „ *Mystaponda vitellus* Linné.
No. 734.	*C. xanthodon*	„ „ *Gratiadusta xanthodon* Sow.

To these must now be added *Palmadusta ziczac* Linné 1758.

The following notes explain some of the above alterations. Hedley allowed as a subspecies *C. errones cruenta*, but Schilder has shown that the best name for "*cruenta*" is *chinensis* Gmelin (Pl. xxiv, figs. 19, 20), and it is a distinct species. In my opinion it is scarcely referable to *Erronea* sensu lato and is at present subgenerically named *Ovatipsa*, the heavy armature of the mouth clearly distinguishing it from typical *Erronea*. In the case of *fimbriata* Schilder has also classed this under *Erronea*, but I can see little close relationship, and have transferred it to *Paulonaria*, while the shell Hedley includes as *C. fimbriata notata* is certainly not *notata* Gill, and has an Australian name *macula* Angas, which is here used specifically, as it is certainly distinct from *fimbriata*.

Erosaria nashi (Pl. xxiv, figs. 5, 6) is introduced for the species Hedley included as *flaveola*; in my Queensland notes I observed that Schilder used *helenæ* Roberts, while Hedley had noted that it might be *labiolineata* Sowerby. Both these are very small shells, the former with coarse, the latter with finer teeth. The large number of specimens collected by Captain Comtesse, and especially Mr. Nash, who has taken a great interest in these shells, shows that the local shell grows fairly large for this series, has medium teeth, small lateral spotting and constitutes a well marked form. The posterior teeth of the inner lip develop first and are strong and well marked before the remainder show up. A normal specimen measures 27 mm. × 15 mm.

Amongst the number collected by Mr. Nash a few, apparently different, were picked out by him; these are broader, the base more convex, the inner teeth much more pronounced, and the lateral spotting obsolete. Similar shells from New Caledonia are named "*spurca*," which they certainly are not, and in some ways recall *rashleighana* Melvill. The different teeth induce me to separate them as *Erosaria percomis* n. sp. (Pl. xxiv, figs. 15, 16).

Gratiadusta vaticina (Pl. xxiv, figs. 11, 12) occurred in numbers and is apparently related to *subviridis*, under which name poor specimens have been recorded. It is a much larger, more solid shell and recalls *anceyi*, but is not so boldly marked and is nearly as large. It is comparatively broader and the dead shells have the base of a beautiful pale cream colour, while the back is blotched with purplish brown, the sides pale cream. A normal shell measures 35 × 24 mm.

With these were specimens of *G. xanthodon*, of large size, and a few shells which appeared referable to *tabescens* Dillwyn, which now should be *teres* Gmelin. They do not agree in general characters with "*Stolida*," and I separate this group as *Talostolida*.

Probably the most interesting species is the form of "*vitellus*," found in the dredgings. This is very solid and comparatively much broader than the "*vitellus*" of Queensland; the white spotting is obsolete and the banding is very noticeable.

The hair lines on the sides run up further, and altogether the shell is distinctive. As more or less normal "*vitellus*" can be found alive in New South Wales, this dead species is here named ***Mystaponda orcina*** sp. nov. (Pl. xxiv, figs. 9, 10). A medium sized specimen measures 43 × 32 mm., while a small Queensland shell goes 50 × 30 mm.

Notocypræa spp.

Some beautiful shells brought in by Captain K. Möller from off the coast of New South Wales indicate that a very distinct faunula of cowries inhabits the continental shelf, apparently closely related to the well-known littoral species. Beddome[55] described an albinistic phase, but the deep-water forms are curiously albinistic in their surface coloration, while retaining deeply coloured spotting on their sides. So far only odd shells have been secured, as the trawl does not bring up quantities of small shells, but the ones already seen are related to the three recognized shore species. These three species may be called *piperita* Gray, *bicolor* Gaskoin, and *comptonii* Gray.

Messrs. Melbourne Ward and W. Boardman brought in a beautiful shell from off the Cape Everard Bank, 70–90 fathoms, which is bluish white above, the edges spotted with orange brown; it is roundly ovate and has the mouth open, the teeth small. It is therefore referable to the "*angustata*" series as arranged by Beddome and for which I use *bicolor* Gaskoin. This deep-water form may be called *Notocypræa (bicolor) emblema* sp. nov. (Pl. xxiv, figs. 3, 4). From 45 fathoms off Twofold Bay, Captain Möller brought in a little shell agreeing with Beddome's *piperata*, fig. 18, but more pallid, the lateral spots bolder, the mouth narrow, the teeth fine; this may be called *Notocypræa (piperita) dissecta* sp. nov. (Pl. xxiv, figs. 7, 8).

Capt. Möller's other specimen from the same place is one of the loveliest little cowries yet seen; it has the upper surface a shining cream, with the sides boldly but profusely spotted with rich brown, the under surface showing the spotting but medially unspotted, the mouth fairly narrow, the teeth fine. It agrees in shape with Beddome's *comptoni*, fig. 16, but not with the typical drawing of *comptonii*. It differs from the two preceding in having an elevated spire, indicating a different genus, and is therefore called *Thelxinovum molleri* gen. et sp. nov. (Pl. xxiv, figs. 17, 18). It may be noted that, while the three littoral species above named occur in southern New South Wales, the shell appearing in Hedley's New South Wales list under the name *C. angustata comptoni* from Sydney is not the same, and is under consideration.

Umbilia (hesitata) howelli nov.

(Pl. xxiv, figs. 1, 2.)

The wonderful cowry originally named *Cypræa umbilicata* has quite an extensive literature but deserves still more. I renamed the normal form ***C. hesitata*** as the well-known name proved invalid. It is now agreed that Verco's ***C. armeniaca*** is specifically distinct and Schilder has named the small form from northern New South Wales. A pure white aberration was named *alba* by Cox,[56] but this is very rare and is undoubtedly an albino. Although hundreds of the

[55] Beddome.—Proc. Linn. Soc. N.S.W., xxii, 1897, pp. 564-576.
[56] Cox.—Proc. Linn. Soc. N.S.W., iv, December 1, 1879, p. 387.

normal form have been trawled off the coast of southern New South Wales, not half a dozen white ones were found. The original name was given to a shallow-water shell found washed up on the beach in Bass Strait. The common trawled shells are slightly larger and less solid but can scarcely be admitted as separable.

In trawling in deeper water, 90–150 fathoms, south of Cape Everard, many larger shells much paler and mixed with many albinisms have been secured. In this case the tendency to albinism is very marked and constitutes a subspecific quality, being accompanied by variation in size and shape. As the name *alba* cannot be maintained, I am calling this magnificent shell after Captain Howell, to whom I am indebted for many examples.

Schilder has given measurements of the normal form when he named *Umbilia hesitata beddomei*,[57] citing the latter as 65–86 against the normal 91–106. The Cape Everard shells all go larger when good specimens are secured, the typical pure white *howelli* measuring 114 mm., another pale shell 119 mm., and the largest I have, though not the largest known, reaching 121 mm. Large specimens of the normal trawled shell measure 101, 101, and 103 mm. The larger *howelli* is undoubtedly more elevated and has more teeth. Among these pale shells a dark form suffused with purple may sometimes be found; in these the base is marked with brown much darker than in the normal form.

Trivellona excelsa gen. et sp. nov.

(Pl. xxiv, figs. 13, 14.)

Shell of medium size for the family, globose, mouth fairly wide, open. Colour of dead shell dirty white.

The aperture is longer than the body whorl, the outer lip descending to meet the inner in front of the somewhat flattened spire. The dorsal view is of a well elevated shell, the liræ running right acros the shell from outer lip to inside the columellar lip. The aperture has the sides fairly parallel. The liræ form loops at the posterior and anterior ends, about six forming the loop, between which are about twelve and twenty-one may be counted on the outer lip, sixteen on the inner lip. Length 18 mm., breadth 13 mm., height 10 mm.

Trawled off Montague Island, New South Wales, in 50–70 fathoms.

The large size of this species separates it at once from all our Triviids, especially as in this depth a form of the littoral *merces* is found which is smaller, more strongly sculptured, the sculpture crossing the back and thus definitely distinguishing it, though the blotches of colour on the dorsal surface are sometimes retained. As no generic name exists for the merces series I propose *Ellatrivia*, and name the deep-water form *Ellatrivia* (*merces*) *addenda* nov.

The New South Wales forms would then read:

Trivia australis Lamarck	should	be	*Ellatrivia merces* Iredale.
cœlatura Hedley	„	„	*Fossatrivia cœlatura* Hedley.
globosa Sowerby	„	„	*Cleotrivia pilula* Kiener.
insecta Mighels	„	„	*Dolichupis insecta* Mighels.
oryza Lamarck	„	„	*Trivirostra scabriuscula* Gray.
staphylœa Linné	„	„	*Staphylœa staphylœa* Linné.

[57] Schilder.—Zool. Anz., xcii, 1930, p. 77.

The last species belongs to the Cypræidæ, not to the Triviidæ, while the fossil relations of *cœlatura* demand the proposition of *Fossatrivia*. To these must be added, as above, *Trivellona excelsa* and *Ellatrivia* (*merces*) *addenda*.

Two or three species from the Harbour dredgings have been sorted out which are those named *globosa*, *insecta*, *oryza* above, but whose names may need emendation later.

Family AMPHIPERATIDÆ.

This name is introduced, following Schilder, for the species classed by Hedley under *Ovula* and *Radius* in the New South Wales list. No fewer than ten species were included, as follows: *Ovula brevis* Sow., *O. bulla* A. Adams and Reeve, *O. dentata* A. Adams and Reeve, *A. ovum* Linné, *O. punctata* Duclos, *O. pyriformis* Sowerby, *O. volva* Linné, *Radius angasi* Reeve, *R. hordaceus* Lamarck, and *R. philippinarum* Sowerby.

These species are all very uncommon and most of the above records are based on few or single specimens. Hedley, dubious of these identifications, took shells to England, and comparisons were made with the types in the British Museum, with the result that most of the determinations were negatived. Captain Comtesse has brought some of the species in, and consequently these are now described as new. First, however, the generic names to be used had to be determined and some facts were cleared up in connection with Queensland forms.[58] Thus the species *ovum* L. is referred to the earlier *Amphiperas* Meuschen, and *Radius* is eliminated in favour of the earlier *Volva* Bolten, the sole New South Wales species being *volva* Linné. It may be, however, that the southern shell should be specifically separated, as it differs in proportions, but is here named *Volva volva cumulata* subsp. nov.

As far as can be judged, there are only two species of the form classed under *Radius* by Hedley, the records *hordaceus* Lamarck and *philippinarum* Sowerby both referring to the species I have named *Phenacovolva nectarea*. When I introduced this name I allowed the typical small *angasi* to be classed under *Prosimnia*, but here rectify this error by proposing *Pellasimnia*, naming *angasi* as type.

I have proposed *Diminovula* with *D. verepunctata* Iredale as type, and this name will replace *O. punctata* in the New South Wales list. I also introduced *Prionovolva* for *O. brevis* Sow., and the record of *O. dentata* A. Adams and Reeve appears to be based upon examples of this species. *O. pyriformis* Sowerby was described from New South Wales, but at that time this name covered Queensland, and while it is a not uncommon shell on the Queensland mainland beaches, there are no specimens available from New South Wales proper. The shell hitherto known as *O. bulla* A. Adams and Reeve is not that species and is here named

Diminovula cavanaghi sp. nov.

(Pl. xxii, figs. 13, 14.)

Shell small, subglobose, pale pink above, white below. The dorsal surface is smooth save for very fine radial growth lines, while very subdued concentric distant keeling can be detected with a lens. Ventrally the outer lip is well curved, advancing over the depressed spire in a sweep and opposed by a raised ridge on the body whorl, a minute posterior canal being formed. Anteriorly the

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[58] Iredale.—Mem. Q'land Mus., x, Aug. 28, 1930, pp. 84-86.

narrow canal is succeeded by a notable tooth, a depression following, the inner lip being a little sinuate. The outer lip is internally roundly obsoletely ridged. Length 18 mm., breadth 11 mm. Rare in Sydney Harbour, New South Wales.

Lachryma bisinventa sp. nov.

(Pl. xxii, fig. 16.)

This is a most interesting discovery, as Hedley concluded "Angas erroneously reported *E*(*rato*) *angistoma* from Sydney Heads."[59] Angas' record reads: "Outside Port Jackson Heads (Brazier). An elegantly shaped species, with the outer lip angulated and produced at the upper part."

I sorted out a specimen from the smaller dredgings of a specimen which immediately recalled this record, but comparison with Torres Strait shells determined as *angistoma* showed the local shell to be more elegantly formed, of a different coloration, and with finer teeth. Smith records[60] the labral teeth as numbering twenty-three, while over thirty can be discerned in our shell.

Cymbiolista hunteri sp. nov.

When I introduced *Cymbiolista* it was regarded as a subgenus only,[61] but more recent study proves that it merits generic rank, and that in the choice of the specific *marmorata* Swainson had been anticipated by Shaw and Nodder,[62] so that the local shell is here renamed *Cymbiolista hunteri* sp. nov.

It is interesting to find the species among the dredgings inside the Harbour, accompanied by *Amorena undulata* Lamarck and *Cymbiolena magnifica* Shaw and Nodder.

This species is named after Captain J. Hunter, who was apparently interested in our shells, as in his account of the settlement at Port Jackson he included three plates figuring the fine "Whelks" now known as *Charonia rubicunda* Perry and *Cymatium spengleri* Perry.

Family TEREBRIDÆ.

Many large Terebrids had been sorted out belonging superficially to *Perirhöe melamans* Iredale, but the keen eye of Mr. E. F. Nash divided them into three and his discrimination is correct. A very different form was that recorded by Hedley in the New South Wales list as *Terebra triseriata* Gray, a rare shell on the North Coast. Comparison of the southern specimens with Gray's figure, his species coming from China, shows that our shell tapers much more slowly and is consequently of different proportions. There is a good name available as Deshayes had described *Terebra prælonga*[63] from Port Curtis, Queensland, and Reeve's figures[64] show agreement with ours and their distinction from the Chinese species. *Triplostephanus* was introduced by Dall for this form of shell, so that the New South Wales species will become known as *Triplostephanus prælongus* (Deshayes). The three forms referable to *Perirhöe* all have the lines punctate, and therefore belong to my subgenus *Dimidacus*; one of them agrees well with

[59] Angas.—Proc. Zool. Soc., 1877, p. 182.
[60] Smith.—Proc. Mal. Soc. (Lond.), ix, 1910, p. 21.
[61] Iredale.—Rec. Aust. Mus., xvii, Sept. 4, 1929, p. 181.
[62] Shaw and Nodder.—Nat. Miscell., xx, 1808, pl. 836.
[63] Deshayes.—Proc. Zool. Soc. (Lond.), Oct., 1859, p. 315.
[64] Reeve.—Conch. Icon., xii, March, 1860, pl. viii, sp. 28.

Terebra albomarginata Deshayes,[65] described from Australia, and not since recognized. Reeve's figure shows a young shell, but Hedley's MS. notes on the type in the British Museum (Natural History) agree with these specimens. The other one is easily separated by its rounded whorls and is like the figure of *Terebra pallida* Deshayes,[66] which was, however, from the Marquesas group, a long way from Sydney Harbour. The Australian shell has longer whorls with post-sutural roll more marked, about sixteen whorls in the same length as the Marquesas shell, whose whorls numbered twenty-seven or twenty-eight. *T. pallida* has been sunk as a synonym of *T. cingulifera* Lamarck, so it is best to name our species and thus keep the form under notice. I therefore introduce the name *Perirhöe exulta* sp. nov. (Pl. xxv, fig. 3).

Darioconus textilis osullivani subsp. nov.

(Pl. xxv, fig. 13.)

Mr. A. W. O'Sullivan collected some mollusca at Black Rock, Richmond River, New South Wales, and indicated two cones which he said he had not collected before. He had collected these alive and they constitute the first record of textile cones from New South Wales. The discrimination of the forms classed around *textilis* is a matter of difficulty without access to large series and museum types. It must be here urged, however, that museum material must be augmented by large acquisitions of correctly localized specimens and worked out by someone who has studied the group in the field before useful conclusions can be achieved. A few recent monographic accounts fail in the latter point and errors are included which field knowledge would have obviated. Thus many textile cones have been collected at various times and at various points on the Great Barrier Reef and they all agree in coloration with the figure of *Conus telatus* Reeve described from unknown locality,[67] and that name might have been accepted were it not that Jickeli had used it for a Red Sea form.[68]

Other specimens, however, have much bolder painting, agreeing better with that shown by Reeve as *Conus vicarius*, and it is to this series that the New South Wales specimens belong. The status of these varieties will need much field study, and it is possible that they may prove to be distinct species. In the meanwhile the local shell may be recorded as *Darioconus textilis osullivani* n. subsp. in order to keep the form found so far south under notice.

A large fine cone was found among the Harbour dredgings by Mr. E. F. Nash, which apparently has passed as *Conus anemone*. Broken pieces have been met with on the beaches and a large similar shell was brought from southern Tasmania by Mr. Melbourne Ward, and it appears to be the form illustrated by May in his "Illustrated Index" as *C. anemone*. It differs altogether from the Kangaroo Island topotypes and is probably referable to a different genus.

The Sydney shell is here illustrated and named *Floraconus peronianus* sp. nov. (Pl. xxv, fig. 12). Shell large, spire very short, mouth a little open, coloration clouds of purple on a creamy ground.

Nine whorls can be counted on the spire, the papillàte protoconch worn but recognizable; the spire is concentrically striate, with six to nine lines. The body

[65] Deshayes.—Proc. Zool. Soc. (Lond.), October, 1859, p. 314. Reeve.—Conch. Icon., xii, pl. xv, sp. 65, May, 1860.

[66] Deshayes.—Journ. de Conch., vi, July, 1857, p. 87, pl. iv, fig. 3.

[67] Reeve.—Conch. Icon., i, February, 1848, Conus suppl., pl. i., sp. and fig. 270.

[68] Jickeli.—Jahrb. deutsch. Malak. Gesell., ii, 1875, p. 65, pl. 1, fig. 2.

whorl smooth, basally weakly lirate, columella slightly twisted, canal short. Length 62 mm., breadth 35 mm.

Apparently ranges along the Peronian region.

For the cone I introduced as *Conus howelli*[69] I propose the new generic name *Endemoconus*, as the erect spire with the concave shouldering of the whorls, and the elongate shape with the narrow aperture easily separate it from any recent Australian shells, and with its fossil relations its strictly endemic nature is emphasized.

Epidirona hedleyi sp. nov.

Hedley figured a Port Jackson shell under the name *Epideira striata* Gray,[70] and apparently neither the generic name nor the specific can be maintained. Hedley introduced *Epideira*, naming as type *Clavatula striata* Gray and citing as illustration *Pleurotoma owenii* Reeve. Gray's species was described without definite locality, but apparently from Western Australia, and the location of the type specimen is unknown. The description, however, shows that it cannot be used for the Sydney shell, disagreement in sculpture and mouth characters being apparent. Reeve described his species from the east coast of Africa, taking the name from Gray's MS. Watson used *owenii* for the Sydney shell,[71] citing Gray's MS. name in the British Museum and questionably adding *P. owenii* Reeve with the comment, "Reeve's figure and description of this species and the locality assigned to it suggest something quite different from the type preserved in the British Museum." This refers to *Gray's* type, not Reeve's, at present untraceable, which was in the Museum Stainforth, now dispersed. Watson adds as locality, "Tonga Islands (Brit. Museum)," which indicates the confusion even in his case, as the Sydney shell does not occur in that group. Consequently *Epideira* Hedley must be relegated to its type *striata* Gray, apparently a West Australian form.

The new genus *Epidirona* is therefore introduced for the species figured by Hedley as *Epideira striata* as above cited, and the specific name is emended to *hedleyi*.

Under the genus *Epideira* Hedley ranged *gabensis* Hedley, *philipineri* Ten.-Woods, *quoyi* Des Moulins, and *torquata* Hedley, a series of closely related species. Collected by Roy Bell in 50–60 fathoms off Green Cape were specimens of *gabensis*, and these seem very close to *torquata* and are scarcely distinguishable. Captain Möller, of the trawlers, picked specimens off the trawl-lines as far north as Montague Island, well in New South Wales waters. In 15 fathoms in Disaster Bay, New South Wales, Roy Bell collected specimens which agree just as well with *philipineri* Ten.-Woods as with *quoyi* Des Moulins as determined by Hedley. These two seem to run very close, but the Disaster Bay shells may be called *philipineri*. These are additions to the New South Wales list and may be classed under *Epidirona*, but may later constitute a recognizable group.

At the same time, in the deep-water dredging Roy Bell collected specimens which I determine as *tasmanica* May, and which Hedley has sunk as a synonym of *xanthophaës* Watson, but Watson's description[72] and figure do not agree, and I

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[69] Iredale.—Rec. Austr. Mus., xvii, September 4, 1929, p. 182, pl. xl, figs. 1, 8.
[70] Hedley.—Rec. Austr. Mus., xiii, September, 1922, p. 250, pl. xliii, figs. 18, 19, 20.
[71] Watson.—Rept. Chall. Zool., xv, 1886, p. 312.
[72] Watson.—Rept. Chall. Zool., xv, 1886, p. 282, pl. xxvi, fig. 1.

will allow May's species[73] at present. This has also been collected from the trawl lines by Captain Möller. I cannot see, however, that this species is congeneric, having a different apex, a much longer canal, and different sculpture, and therefore propose for May's *tasmanica* the new genus *Epidirella*.

Eugemmula hawleyi gen. et sp. nov.

(Pl. xxv, figs. 11, 14.)

A very beautiful Turrid attracted attention, and recognition of it as a member of the genus "*Gemmula*" showed that hitherto few specimens had been collected in north Queensland and none in New South Wales. Hedley's Revision[74] allowed three species, *græffei* Weinkauff, *hombroni* Hedley and *monilifera* Pease, all from north Queensland. The first named had been described from the Fiji Islands, the second from Torres Strait, and the third from the Hawaiian Islands. Our specimens do not agree with Weinkauff's figures, nor with Hombron and Jacquinot's figures of the Torres Strait species. As Pease's name is preoccupied it is unnecessary to investigate the standing of that species in connection with Australian shells. Hedley has pointed out that Cossmann selected *gemmata* Reeve as type of *Gemmula*, but as that is a West American shell with a longer canal and different apex our species cannot be maintained in that group. I have also a recollection, which I cannot verify here, that *Gemmula* is invalid. I therefore propose *Eugemmula* with *hawleyi* here described as type for the Australian species.

Shell elegantly fusiform with long tapering spire and fairly long canal, the apertural sinus well marked, deep, just above the periphery.

Colour of dead shells, bright fawn, sometimes worn pink on periphery. The apical whorl and a half is smooth, succeeding whorl longitudinally ribbed and the next half similar, ending in a varix as if a *Sinusigera* protoconch. Adult sculpture consists of a thread below the suture, succeeded by a depression, which is followed by an elevated row of gemmules, which constitute the family sinus; below on the penultimate whorl two cingula can be seen, and on the last four prominent ones above the long canal. Between these cingula appear threads, and faint growth line radials can be discerned. Columella straight, smooth, inner lip slight, outer lip thin and sharp. In the dozen specimens already collected great variation in form is seen; some are broad, others narrow but more material is needed to determine whether two species are being confused.

The type measures 35 mm. in length and 12 mm. in breadth.

A broad shell measures 33 mm. by 13 mm. and a narrow one 31 mm. by 9 mm.

A curious large Turrid picked out by Mr. E. F. Nash agrees with no known group of Australian range, and is here introduced as *Clamturris incredula* gen. et sp. nov. (Pl. xxv, fig. 21). It suggests *Xenuroturris*, but is of different texture, being stout and hard. Though the apex is missing nine whorls remain, and the spire is very long and the canal short. Colour of dead shell uniform rich reddish brown. The sculpture consists of spiral liræ, alternately stronger and weaker, ten to twelve being counted on the penultimate whorl. The fasciole provides a raised belt, making the whorls semi-angulate medially. The columella is nearly straight, the inner lip developed as a thick glaze crossing the body whorl to join the outer lip. Outer lip broken but showing a deep narrow sinus of the Turrid type. Length 60 mm., breadth 21 mm.

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[73] May.—Proc. Roy. Soc. Tasm., 1910, p. 391, pl. xiii, fig. 16.
[74] Hedley.—Rec. Aust. Mus., xiii, September 30, 1922, p. 217.

Fusus pricei Smith.

A very abnormal "Fusus" was described by Smith[75] under the name *Fusus corpulentus* from unknown locality, and five years later, receiving from Mr. Charles Price two specimens which had been collected either at Cleveland Bay, north Queensland, or in New Guinea, which he determined as conspecific, he emended the name to *Fusus pricei*,[76] his first choice having been anticipated. Two or three suggestions as to its generic location have been offered, and Hedley took refuge in *Galeodes*, but that generic name is invalid. A small specimen picked out by Mr. E. F. Nash agrees with the Queensland shells, but does not show the subgranular sculpture of the type, neither is the shouldering of the whorls concave and the liræ are more pronounced, so that it should be separated subspecifically as *Saginafusus pricei perficus* subsp. nov. (Pl. xxiii, fig. 1).

Phos senticosus (Linné).

The generic name *Phos* has appeared more than once in the records of extratropical Australian Mollusca, but each time has later been rejected. This time, however, it may be correctly retained, as the type of *Phos* Montfort, *P. senticosus*[77] is the species under consideration, a beautiful specimen being picked out by Mr. E. F. Nash (Pl. xxiii, fig. 9).

Linné's *Murex senticosus*[78] was ascribed to no locality but tradition refers this species to his introduction.

Pinaxia coronata auct.

The genus *Pinaxia* was introduced by A. Adams before the Zoological Society of London in 1853,[79] but the description and figure did not appear in print until eighteen months later. This reference was cited by Dall[80] when he lumped this remarkable generic form under *Thais* and changed the name to *Thais adamsi* on account of the prior *Purpura coronata* Lamarck 1822. Lamarck's name even dated back to 1816,[81] but obviously the species was not congeneric.

It is curious that Dall's action was based on Smith's report[82] that the animal of *Pinaxia* was "purpuroid" because he overlooked the fact that Smith had recorded that *Pyrula versicolor* Gray[83] was the same species and had priority. Smith did not use Gray's name because the specimen was immature and since then it has been neglected. Reversion must now be made, and very little appears to be known of the distribution of this peculiar little form, as, while A. Adams' shells came from the Philippines, Smith's came from Ceylon, and Gray's had no definite locality, simply Pacific Ocean.

Mr. E. F. Nash has picked out two specimens, thus adding a very interesting record to the Australian fauna. Both are immature, and, as there is no series for comparison, only the general name *Pinaxia versicolor* Gray can be used at present.

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[75] Smith.—Ann. Mag. Nat. Hist., (5), ix, May, 1882, p. 344, fig. in text.
[76] Smith.—Journ. Conch. (Leeds), v, November 12, 1887, p. 237.
[77] Montfort.—Conch. Syst., ii, 1810, pp. 494-5.
[78] Linné.—Syst. Nat., 10th ed., p. 751.
[79] A. Adams.—Proc. Zool. Soc. (Lond.), 1853 (May 16, 1855), p. 185.
[80] Dall.—U.S. Geol. Survey, Prof. Papers, No. 59, 1909, p. 50, footnote.
[81] Lamarck.—Ency. Meth. Liste to pls. Moll., p. 2, for pl. 397, f. 4.
[82] Smith.—Ann. Mag. Nat. Hist., (4), xv, April, 1875, p. 300.
[83] Gray.—Zool. Beechey. Voyage of the "Blossom," 1839 (pref. July), p. 114.

Family ARCHITECTONICIDÆ.

Hedley has included under *Architectonica* six species, as follows: *atkinsoni* Smith, *layardi* Adams, *lutea* Lamarck, *maxima* Philippi, *perspectiva* Linné, and *reevei* Hanley. In the family also appears the genus *Heliacus* with three species, *crenellus* Linné, *foveolatus* Tate, and *stamineus* (recte *stramineus*) Gmelin, and the genus *Discohelix* with the species *meridionalis* Hedley. Two families are here confused, as the animal of *Heliacus* is very distinct from that of *Architectonica*, and the so-called *Discohelix* must be associated with the Heliacoid species. To deal with the species of *Architectonica* first, the type is *perspectiva* Linné, so that generic name may be retained, but the New South Wales shells do not agree with Queensland specimens superficially referable to the Linnean species. Hedley identified them as *maxima* Philippi, but that species disagrees in size and markings, to that the Sydney species is here described as new. Smith's *atkinsoni* was described from the ill-fated "Challenger" Station 164 B, said to be 410 fathoms off Sydney, and the young smooth shell has to be contrasted with shells from around the supposed type locality before it can be definitely recognized.

In the Museum collection two distinct species from deep-water have been determined as Smith's species, but neither agrees with the description. *Philippia layardi* was described by A. Adams from Ceylon, and Hanley wrote: "The type of *Layardi* is only a young and hence depressed form of this variable species." Angas added it to the New South Wales list at the same time as he added *hybrida*, both collected by Brazier at Lake Macquarie beach, differentiating them thus, placing both in the genus *Philippia*:—"*P. hybrida*: White, ornamented with broad pale brown flames. *P. layardi*: Flatter and more keeled than the preceding species, with the ground-colour rich brown, ornamented with white on the keel and round the umbilicus." Unfortunately Angas' determinations cannot now be checked, but it is obvious that *layardi* must be rejected.

Solarium reevei was described by Hanley from unknown locality and was based on an abnormal shell. This was figured by Sowerby, with the locality Sydney added, and Angas included it in the New South Wales list on that basis, but the figure does not agree with the Sydney species in the strength of the sculpture, general shape, and especially the width of the umbilicus. Hanley especially stressed the fact that its conical shape was due to abnormality, whereas the Sydney shell is normally even more elevated.

Architectonica grandiosa sp. nov.

(Pl. xxv, figs. 19, 20.)

Shell large, conical, whorls slightly convex, periphery sharply angulate, whorls eight, umbilicus large and perspective. Coloration: each whorl is bounded by a raised cingulum of cream, regularly blotched with reddish brown, the intervening space varying from deep pink to deep cream. The base shows an unspotted wrinkled rib surrounding the umbilicus, followed by a spotted one, then an intervening space, which is also spotted, and two spotted ribs at the edge. The sculpture consists of oblique evenly spaced cuts, overriding the earlier whorls, where a couple of concentric grooves are seen, but with growth both cuts and grooves decrease in strength and become obsolete on the last whorl, a fine striation only appearing there. The base is similarly striate. Columella straight, perpendicular, basally terminating in a notched projection. Mouth subquadrate.

Breadth 45 mm., height 20 mm.

Architectonica offlexa sp. nov.

(Pl. xxv, figs. 15, 16.)

Shell small, like an elevated miniature of the preceding, the whorls straighter, umbilicus narrower but still perspective. Whorls seven, plus anastrophic protoconch. Coloration above similar but much paler, the dark blotching weaker, but the base is unspotted.

In the minor details of sculpture the central grooving of the whorls is missing and there is an additional thread along the suture; the sculpture is more persistent and is present, though less marked, on the last whorl. Columellar and apertural features as in the preceding.

Breadth 20 mm., height 12 mm.

Philippia manifesta sp. nov.

(Pl. xxv, figs. 19, 20.)

Shell small, larger than the type of *Philippia*, whorls convex though angled sharply at the periphery, smooth, perspectively umbilicate. Whorls five.

Coloration: ground colour cream, almost hidden by brownish yellow blotching. Sculpture none, except growth lines and peripheral and sutural keels and threads. Above the suture are two threads which persist on the last whorl as the peripheral keel and a thread above, while another thread is seen below; a wrinkled rib surrounds the umbilicus, and in front of it is another less wrinkled one.

Columellar and apertural characters as in *Architectonica*.

Breadth 15 mm., height 10 mm.

Philippia stipator sp. nov.

(Pl. xxv, figs. 17, 18.)

Shell superficially like the preceding but coloration different and the base more convex, the umbilicus narrow but deep. Whorls five.

Coloration: White, a yellow band below the suture radiating rays to the periphery; this colour scheme is well known as that of *cingulum* Kiener = *radiata* Bolton.

Sculpture: The whorls are smooth save for two equal liræ which bound the lower edge and constitute the peripheral keel with its antecedent ridge; a similar ridge succeeds the keel and is seen on the last whorl only. Base convex, smooth, umbilicus narrow, bounded by a wrinkled rib, with a very much smaller one adjacent.

Breadth 13 mm., height 9 mm.

Solatisonax injussa gen. et sp. nov.

(Pl. xxv, figs. 7, 8.)

Smith described *Solarium atkinsoni*[84] from the "Challenger" Station 164 B, 410 fathoms off Sydney, and a very fine shell secured by the trawlers has been hitherto regarded as conspecific.

This shell seems a deep-water relative of *Architectonica* with finer sculpture, and Smith's shell seems a dweller of still deeper water, as it is apparently smoother and was described from a very immature specimen.

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[84] Smith.—Proc. Zool. Soc. (Lond.), 1891, p. 441, pl. 35, fig. 19.

Shell medium, conical, whorls very slightly convex, texture thin, umbilicus wide, deep and perspective. Whorls seven, plus anastrophic protoconch. Coloration uniform fawn in dead shell.

Protoconch anastrophic succeeded by planate whorl showing a median ridge succeeded by a depression; the strength of this ridge depends upon the tilting of the anastrophe. The ridge is finely nodulous, the nodules decreasing with age and soon becoming obsolete; with their degeneracy the succeeding depression becomes less marked, so that it is not noticeable on the last whorl. Fine spiral threads run concentrically in the groove, while still finer lines run along the remainder of the whorl, where, however, fine radial growth lines show up rather strongly. The acute keel of the whorl is simple, there remaining only indications of the series seen in shallow water species of Architectonicids. The base is a little convex, sculptured with revolving spiral lines, about twenty in number, never very strong and becoming weaker towards the mouth, where the growth lines become more pronounced. Around the deep crater-like umbilicus a weakly beaded edge persists, succeeded by a couple of weaker liræ a little beaded; there is no radial umbilical sculpture. The columella is a little sinuate, the anterior canal scarcely marked, the aperture subquadrate and the outer lip thin.

Breadth 25 mm., height 14 mm.

The type comes from about 100 fathoms between Gabo and Flinders Island, Bass Strait.

Palamharpa gen. nov.

(Pl. xxii, fig. 8.)

This generic name is introduced with the new species *P. exquisita* as type. Over thirty years ago Verco described *Harpa punctata*[85] dredged in 20-22 fathoms in South Australian waters, observing: "The discovery of a new species (of *Harpa*) is, therefore, of peculiar interest." Nearly twenty years afterward Verco added that only three more examples had been found, and that the species should be transferred to *Eocithara* proposed by Fischer for Eocene Parisian fossils.[86] Verco then referred to nine species of fossils described under *Harpa*, and regarded all as referable to the one genus *Eocithara*.

It was necessary to study these in order to ascertain the relationship of a beautiful shell trawled, and discrepancies were at once noted. Tate[87] had described eight of these at the one time, four from the "Lower Beds at Muddy Creek," *viz.*, *Harpa lamellifera*, *H. sulcosa*, *H. abbreviata* and *H. tenuis*, two from "blue" clays at Schnapper Point, *H. spirata* and *H. pulligera*, one from a well-sinking in the Murray Desert, *H. cassinoides*, and the eighth from calciferous sandstones, River Murray Cliffs, *H. clathrata*. Of these, *H. lamellifera* and *H. sulcosa* may be classed together under the generic name *Refluharpa*, while *H. spirata* is separable with the new generic name *Trameharpa*. The other five may be grouped for the present under the name *Deniharpa*.

The later described *Harpa pachycheila* Tate[88] can be compared with *abbreviata*. With none of these does the present recent species coincide.

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[85] Verco.—Trans. Roy. Soc. South Austr., xx, 1896, p. 218, pl. vi, fig. 3.
[86] Verco.—Trans. Roy. Soc. South Austr., xxxvii, 1913, p. 446.
[87] Tate.—Trans. Roy. Soc. South Austr., xi, 1888 (April, 1889), p. 149.
[88] Tate.—Journ. Proc. Roy. Soc. N.S.W., xxvii, March, 1894, p. 173, pl. xi, fig. 5.

Shell small, harpiform, spire short, whorls a little shouldered. Colour pale brown. Whorls four, with a two-whorled bulbous protoconch. Sculpture consists of somewhat distant, flattened, concentric ridges, overriden by fine erect ridges, whose interstices are finely threaded; there are about twenty-five major ridges on the last whorl, with four to six threads between. About thirteen concentric ridges occur on the last whorl. Inner lip as a thick glaze, outer lip thickened. Height 24 mm., breadth 14 mm.

Scæofax gen. nov.

(Pl. xxiii, fig. 8.)

This generic name is provided for a very interesting new species brought in from the Cape Everard Bank by Captain Möller, after whom I name the type species *S. molleri*. This shell is very like *Fax* but is of stouter build and more complex sculpture and recalls *Zephos otagoënsis* Finlay from off Otago Heads, New Zealand, in 50 fathoms.[89] A more slender form otherwise very similar had been secured in the same waters by the "Endeavour," and had been identified by Hedley as *Arcularia grandior* Verco.[90] Verco's species had been dredged in 110 fathoms off Beachport, South Australia, and is still more slender than my shell, which is more solid with more pronounced sculpture.

Hedley included under *Xymene*, *Buccinum contractum* Reeve, having previously suggested that this species intergraded with *X. hanleyi*. The species referred to is here named *Ergalatax recurrens* gen. et sp. nov., the figured specimen coming from the Sydney Harbour dredgings (Pl. xxiii, fig. 10). It is regularly short fusiform, the canal short, the spire being equal in length to the aperture. Colour white. The apical whorls are missing but seven adult whorls remain; these are longitudinally ribbed with elevated rounded ribs, eight to a whorl, overrun by spiral liræ adorned with overlapping scales. Columella smooth, nearly straight, outer lip thickened inside, outer edge thin, nine teeth in interior. Length 25 mm., breadth 13 mm.

This genus occurs northward to Torres Strait, and there is variation throughout the range, but it is not related to *Xymene*. On Pl. xxiii, fig. 7, is figured a shell I have determined as an aberration of *Sydaphera renovata* Iredale, but there is no apparent reason for the deformity, and it is curious that we have elongated species in this family.

The new names proposed are here tabulated:

Solemya velesiana sp. nov.
Solemyarina gen. nov.: type *Solemya velesiana* Iredale.
Ennucula gen. nov.: type *Nucula obliqua* Lamarck.
Ennucula astricta sp. nov.
Ennucula duritas sp. nov.
Deminucula gen. nov.: type *Nucula prætenta* Iredale.
Grandaxinæa gen. nov.: type *Glycymeris magnificens* Iredale.
Tucetona gen. nov.: type *Pectunculus flabellatus* Ten.-Woods.
Veletuceta gen. nov.: type *Glycymeris flammeus* Reeve.
Veletuceta fossa sp. nov.
Veletuceta thackwayi sp. nov.

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[89] Finlay.—Trans. New Zeal. Inst., Vol. lvii, 1926, p. 417, fig. 81.
[90] Verco.—Trans. Roy. Soc. South Aust., xxxii, 1908, p. 344, pl. xv, figs. 16, 17.

Melaxinæa litoralis sp. nov.
Versipella gen. nov.: type *Versipella soboles* Iredale.
Versipella soboles sp. nov.
Senectidens gen. nov.: type *Senectidens dannevigi* Iredale.
Senectidens dannevigi sp. nov.
Aspalima solator sp. nov.
Glycilima gen. nov.: type *Glycilima paradoxa* Iredale.
Glycilima paradoxa sp. nov.
Cosa sagana sp. nov.
Cosa pharetra sp. nov.
Malleus novelesianus sp. nov.
Parimalleus gen. nov.: type *Parimalleus cursator* Iredale.
Parimalleus cursator sp. nov.
Austropteria gen. nov.: type *Austropteria saltata* Iredale.
Austropteria saltata sp. nov.
Spondylus prionifer sp. nov.
Plicatula essingtonensis elusa subsp. nov.
Varotoga gen. nov.: type *Solecardia cryptozoica* Hedley.
Lactemiles gen. nov.: type *Scintilla strangei* Deshayes.
Velargilla gen. nov.: type *Naranio rubiginosa* A. Adams and Angas.
Quadrans parvitas sp. nov.
Thalotia comtessei sp. nov.
Fautor excultus sp. nov.
Carswellena gen. nov.: type *Turbo exquisitus* Angas.
Laciniorbis morti sp. nov.
Laciniorbis hedleyi sp. nov.
Opposirius gen. nov.: type *Opposirius idoneus* Iredale.
Opposirius idoneus sp. nov.
Dolichosirius gen. nov.: type *Dolichosirius cupiens* Iredale.
Dolichosirius cupiens sp. nov.
Euprotomus donnellyi sp. nov.
Doxander gen. nov.: type *Strombus vittatus* Gmelin.
Dolomena gen. nov.: type *Strombus pulchellus* Reeve.
Canarium otiolum sp. nov.
Distorsio francesæ sp. nov.
Dulcerana gen. nov.: type *Ranella granifera* Lamarck.
Gyrineum pacator sp. nov.
Xenogalea nashi sp. nov.
Xenogalea thomsoni palinodia subsp. nov.
Quimalea pomum macgregori subsp. nov.
Parvitonna gen. nov.: type *Parvitonna perselecta* Iredale.
Parvitonna perselecta sp. nov.
Ficus margaretæ sp. nov.
Problitora gen. nov.: type *Amauropsis morchi* A. Adams and Angas.
Ectosinum gen. nov.: type *Ectosinum pauloconvexum* Iredale.
Ectosinum pauloconvexum sp. nov.
Pervisinum gen. nov.: type *Pervisinum dingeldeii* Iredale.
Pervisinum dingeldeii sp. nov.
Gennæosinum intercisum sp. nov.

Erosaria nashi sp. nov.
Talostolida gen. nov.: type *Cypræa teres* Gmelin.
Gratiadusta vaticina sp. nov.
Ovatipsa subgen. nov.: type *Cypræa chinensis* Gmelin.
Erosaria percomis sp. nov.
Mystaponda orcina sp. nov.
Notocypræa (*bicolor*) *emblema* sp. nov.
Notocypræa (*piperita*) *dissecta* sp. nov.
Thelxinovum gen. nov.: type *Thelxinovum molleri* Iredale.
Thelxinovum molleri sp. nov.
Umbilia (*hesitata*) *howelli* nov.
Trivellona gen. nov.: type *Trivellona excelsa* Iredale.
Trivellona excelsa sp. nov.
Ellatrivia gen. nov.: type *Trivia merces* Iredale.
Ellatrivia (*merces*) *addenda* sp. nov.
Fossatrivia gen. nov.: type *Trivia cælatura* Hedley.
Volva volva cumulata subsp. nov.
Pellasimnia gen. nov.: type *Ovulum angasi* Reeve.
Diminovula cavanaghi sp. nov.
Lachryma bisinventa sp. nov.
Cymbiolista hunteri sp. nov.
Perirhöe exulta sp. nov.
Darioconus textilis osullivani subp. nov.
Floraconus peronianus sp. nov.
Endemoconus gen. nov.: type *Conus howelli* Iredale.
Epidirona gen. nov.: type *Epidirona hedleyi* Iredale.
Epidirona hedleyi sp. nov.
Epidirella gen. nov.: type *Hemipleurotoma tasmanica* May.
Eugemmula gen. nov.: type *Eugemmula hawleyi* Iredale.
Eugemmula hawleyi sp. nov.
Clamturris gen. nov.: type *Clamturris incredula* Iredale.
Clamturris incredula sp. nov.
Saginafusus gen. nov.: type *Fusus pricei* Smith.
Saginafusus pricei perficus subsp. nov.
Architectonica grandiosa sp. nov.
Architectonica offlexa sp. nov.
Philippia manifesta sp. nov.
Philippia stipator sp. nov.
Solatisonax gen. nov.: type *Solatisonax injussa* Iredale.
Solatisonax injussa sp. nov.
Palamharpa gen. nov.: type *Palamharpa exquisita* Iredale
Palamharpa exquisita sp. nov.
Refluharpa gen. nov.: type *Harpa lamellifera* Tate.
Trameharpa gen. nov.: type *Harpa spirata* Tate.
Deniharpa gen. nov.: type *Harpa clathrata* Tate.
Scæofax gen. nov.: type *Scæofax molleri* Iredale.
Scæofax molleri sp. nov.
Ergalatax gen. nov.: type *Ergalatax recurrens* Iredale.
Ergalatax recurrens sp. nov.

EXPLANATION OF PLATES.

Plate XXII.

Fig. 1.—*Laciniorbis hedleyi* Iredale, upper view.
Fig. 2.—*Laciniorbis hedleyi* Iredale, under view.
Fig. 3.—*Laciniorbis hedleyi* Iredale, side view.
Fig. 4.—*Laciniorbis morti* Iredale, upper view.
Fig. 5.—*Laciniorbis morti* Iredale, side view.
Fig. 6.—*Laciniorbis morti* Iredale, under view.
Fig. 7.—*Opposirius idoneus* Iredale.
Fig. 8.—*Palamharpa exquisita* Iredale.
Fig. 9.—*Dolichosirius cupiens* Iredale.
Fig. 10.—*Quadrans parvitas* Iredale.
Fig. 11.—*Quadrans parvitas* Iredale, hinge.
Fig. 12.—*Quadrans parvitas* Iredale, hinge.
Fig. 13.—*Diminovula cavanaghi* Iredale, upper view.
Fig. 14.—*Diminovula cavanaghi* Iredale, under view.
Fig. 15.—*Fautor excultus* Iredale.
Fig. 16.—*Lachryma bisinventa* Iredale.

Plate XXIII.

Fig. 1.—*Saginafusus pricei perficus* Iredale.
Fig. 2.—*Distorsio francesæ* Iredale.
Fig. 3.—*Gyrineum pacator* Iredale.
Fig. 4.—*Ficus margaretæ* Iredale.
Fig. 5.—*Tutufa lissostoma* Smith.
Fig. 6.—*Canarium otiolum* Iredale.
Fig. 7.—*Sydaphera renovata* Iredale, aberration.
Fig. 8.—*Scæofax molleri* Iredale.
Fig. 9.—*Phos senticosus* Linné.
Fig. 10.—*Ergalatax recurrens* Iredale.
Fig. 11.—*Thalotia comtessei* Iredale.
Fig. 12.—*Dolomena pulchella* Reeve.
Fig. 13.—*Gennæosinum intercisum* Iredale.
Fig. 14.—*Gennæosinum intercisum* Iredale, type.
Fig. 15.—*Pervisinum dingeldeii* Iredale.
Fig. 16.—*Ectosinum pauloconvexum* Iredale.
Fig. 17.—*Parvitonna perselecta* Iredale.
Fig. 18.—*Xenogalea nashi* Iredale.
Fig. 19.—*Euprotomus donnellyi* Iredale.
Fig. 20.—*Xenogalea thomsoni palinodia* Iredale.
Fig. 21.—*Semicassis diuturna* Iredale.
Fig. 22.—*Quimalea pomum macgregori* Iredale.
Fig. 23.—*Tonna allium* Dillwyn.
Fig. 24.—*Tonna parvula* Tapp-Canefri.
Fig. 25.—*Tonna canaliculata* Linné.
Fig. 26.—*Tonna tetracotula* Hedley.

Plate XXIV.

Figs. 1, 2.—*Umbilia* (*hesitata*) *howelli* Iredale, side and under views.
Figs. 3, 4.—*Notocypræa* (*bicolor*) *emblema* Iredale.
Figs. 5, 6.—*Erosaria nashi* Iredale.
Figs. 7, 8.—*Notocypræa* (*piperita*) *dissecta* Iredale.
Figs. 9, 10.—*Mystaponda oreina* Iredale.
Figs. 11, 12.—*Gratiadusta vaticina* Iredale.
Figs. 13, 14.—*Trivellona excelsa* Iredale.
Figs. 15, 16.—*Erosaria percomis* Iredale.
Figs. 17, 18.—*Thelxinovum molleri* Iredale.
Figs. 19, 20.—*Erronea* (*Ovatipsa*) *chinensis* Gmelin.

PLATE XXV.

Fig. 1.—*Spondylus prionifer* Iredale.
Fig. 2.—*Perirhöe melamans* Iredale.
Fig. 3.—*Perirhoë exulta* Iredale.
Fig. 4.—*Perirhoë albomarginata* Deshayes.
Figs. 5, 6.—*Plicatula essingtonensis elusa* Iredale.
Figs. 7, 8.—*Solatisonax injussa* Iredale.
Figs. 9, 10.—*Philippia manifesta* Iredale.
Fig. 11.—*Eugemmula hawleyi* Iredale.
Fig. 12.—*Floraconus peronianus* Iredale.
Fig. 13 —*Darioconus textilis osullivani* Iredale.
Fig. 14.—*Eugemmula hawleyi* Iredale.
Figs. 15, 16.—*Architectonica offlexa* Iredale.
Figs. 17, 18 —*Philippia stipator* Iredale.
Figs. 19, 20.—*Architectonica grandiosa* Iredale.
Fig 21.—*Clamturris incredula* Iredale.

CONTRIBUTIONS TO THE CRANIAL OSTEOLOGY OF THE FISHES.

No. VII.

The Skull of *Neoceratodus forsteri*: A Study in Phylogeny.

By

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Introduction and Acknowledgment.

Recent work on the development of the Dipnoi, ganoids, and amphibians, and the increase of our knowledge of the constitution of the stegocephalian and cotylosaurian skulls, throw much light on the interpretation and significance of the structure of the adult skull of *Neoceratodus*. That this was so very soon became apparent to me whilst engaged upon a general survey of the skull of *Neoceratodus* in connection with a paper on the evolution of the Anamniota[1] and it was then decided to investigate the matter in more detail at a later date.

In the following pages I have recorded the observations made and the conclusions arrived at after comparing the various structures with those of the fishes and primitive tetrapods. This work has been made possible by the kindness of Dr. Thos. L. Bancroft, of Eidsvold, Queensland, who forwarded me three adult heads carefully preserved in alcohol; to him my thanks are tendered.

From one of these heads I have been fortunate in preparing a chondrocranium in a perfect state of preservation, denuded of every last scrap of tissue and of the investing bones, the latter being, of course, available for study as separate disarticulated bones. This was effected by over two years' careful maceration in alternating changes of calcium hypochlorite solution and water. Another of the skulls was dissected with a view to studying the relation of the nerves and more important blood vessels to the cranium. The third was divided along the sagittal plane; one-half was dissected to expose the bones in situ, the other was more rapidly macerated with a view to determining the extent and relations of the subnasal and labial cartilages. I failed to find the labial cartilages, and have reason to believe that the structures so named are fibro-cartilaginous, as are the subnarial cartilages, and, like them, devoid of serial homological significance.

[1] Kesteven.—Rec. Austr. Mus., xviii, 1931, pp. 167-200.

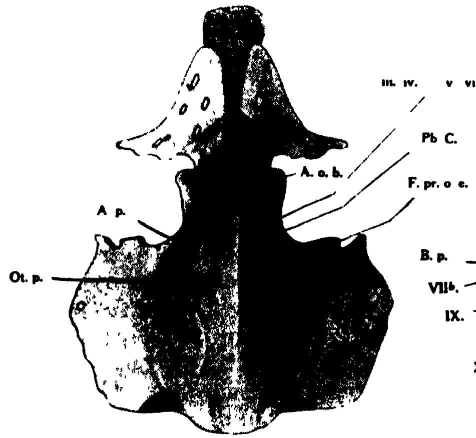
PART I.

THE CHONDROCRANIUM AND ITS BEARING ON THE PROBLEM OF THE ORIGIN OF THE TETRAPODS AND OF THE DIPNOI.

A. DESCRIPTION OF THE CHONDROCRANIUM.

The general shape of the chondrocranium is well shown in Figures 1-4.

The cranial cavity is rather narrower than might be expected on viewing the complete structure. Its widest part is in the region of the otocrane, about half way between the pituitary fenestra and the posterior end of the specimen



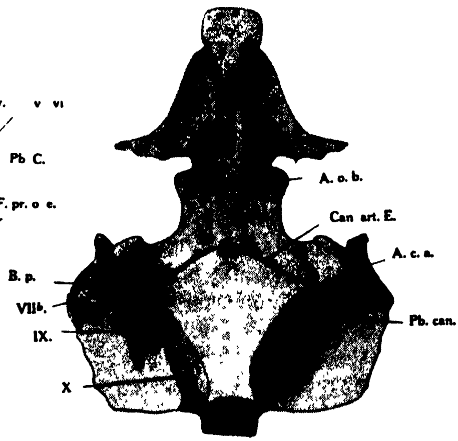


Fig. 1—Dorsal aspect of the Chondrocranium of *Neoceratodus*.
Fig. 2—Ventral aspect of the Chondrocranium of *Neoceratodus*.

figured. It is here a little less than one-half the width of the flattened area of the basis cranii covered by the parasphenoid bone. It extends forward as far as the antorbital buttress. The form and position of the otocrane and trigemino-facial fossa are very similar to the piscine condition.

The great width of the posterior portion of the cranium is due to the very solid and widely attached quadrates and the expansive arched sheet of cartilage that, attached along the outer and upper edge of the quadrate and its otic root, extends backward to roof over the gills, and is attached to the outer and upper part of the otocrane and cranium behind it. The line of attachment to the otocrane and cranium is tunnelled by a canal (sensory canal), which commences in front at the foramen prooticum externum and opens behind above the foramen X. This canal is plainly seen through the cartilage and is indicated in the drawing.

In front of the anterior root of the quadrate the cranium is markedly constricted at the orbit; this is bounded anteriorly by an anorbital buttress, which is stouter and more pronounced below, where it overlies the outer portion of the palatine component of the pterygo-palatine bone.

In the region of the orbit the cranium is triangular in cross section, the base of the triangle being the base of the cranium.

In front of the antorbital buttress the cranium becomes quadrilateral in cross section and the cranial cavity gives place to the two olfactory passages, separated

by the mesethmoid cartilage. The roofing sheet of cartilage here is almost horizontal, and it extends further forward than the floor of the olfactory passages. Above the olfactory passages this ethmoidal roofing cartilage is obliquely truncated on each side, and is then continued forward much narrowed to just in front of the situation of the posterior boundary of the anterior narial apertures, when it is again expanded and then abruptly truncated. The nasal septum is deepest behind, between the openings of the olfactory passages, and gradually diminishes in depth as it passes forward, but presents a slight abrupt increase in depth immediately in front of the palatine symphysis. Anteriorly the cranium terminates in a horizontal prenarial spatulate sheet of cartilage with two small fenestræ near the margin, one on either side of the mid-line.

The tectum nasi is a very thin irregularly fenestrated sheet of cartilage, attached as shown to the lateral edge of the expanded upper edge of the nasal septum and to the obliquely truncated anterior margin of the mesethmoidal roofing cartilage. Its general shape is indicated in the drawing.

There is no trace of any solum nasi. At first it was thought that perhaps the arcuate subnarial cartilage lying behind and curving round the outer margin of the posterior narial aperture might represent a primitive solum nasi, but this is a fibro-cartilaginous structure and is attached, not to the chondrocranium, but to the fibrous mass that invests the ascending process of the palatine and descending process of the dermal ectethmoid. Both its structure and attachment would seem, then, to contra-indicate any such interpretation of the subnarial cartilage.

The three primitive roots of the quadrate are readily recognizable. The ascending process, or anterior root, lies in front of the large canal from the trigemino-facial fossa, and above that for the hyomandibular trunk of nerve VII.

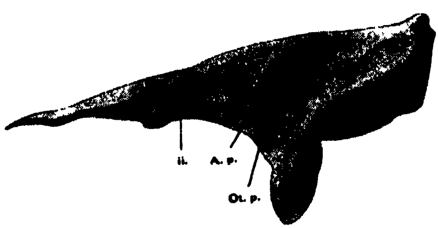


Fig. 3.—Lateral aspect of the Chondrocranium of *Neoceratodus.*

The otic process, posterior superior root, is placed above and behind the former of these two canals, and is separated from the basal process, posterior inferior root, below it by a large branch of the parabasal canal. The anterior portion of the parabasal canal, which transmits the ophthalmic artery, lies between the basal and ascending processes. Immediately in front and to the inner side of the anterior aperture of this last canal there is a flange of cartilage which connects the basal process with the mesethmoid region of the cranium below the exit of nerve V1. This little flange was regarded by Bridge[2] as "representing the palatopterygoid cartilage." This, however, it cannot be, as indicated by the development of the quadrate (*vide* Edgeworth[3] and Greil[4]).

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[2] Bridge.—Trans. Zool. Soc., Lond., xiv, 1898, p. 352.
[3] Edgeworth.—Journ. Anat., lix, 1925, pp. 225-264.
[4] Greil.—*In* Semon's Zoolog. Forschungsr. Austr. Malay. Archipel., i, 6, 1908, pp. 661-934.

The whole of the area on the base of the cranium covered by the parasphenoid and pterygo-palatine bones is level, except for a shallow sulcus, slightly deeper in front, for the reception of the palatine symphysis. Viewed from below the

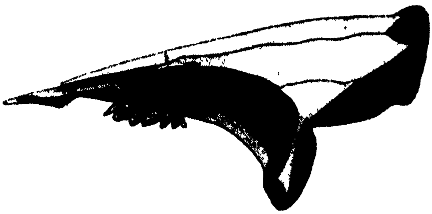

Fig. 4.—The same as Fig. 3, but with the major bones in place.

antorbital buttress stands out prominently where it lies above the palatine bone, and just in front of this the oblique inferior margin of the anterior aperture of the olfactory canal is visible.

Describing teleostean skulls, I have recognized occipital mesotic, preotic and prepituitary segments of the cranial floor.[5] These same segments are recognizable in the floor of chondrocranium of *Neoceratodus*, but one notes at once the much greater extent of the prepituitary segment, correlated, of course, with the greater development of the prosencephalon. As in the teleostean skull, the mesotic segment is largely wanting, owing to the encroachment of the cava sacculi. Except for the greater extent of the preotic area, there is also a marked similarity in the side wall to that of the teleostean skull. There is no outstanding ridge dividing the trigemino-facialis fossa from the lateral cranial fenestra, as these two are divided by bone in the bony crania, and the cranial temporal fossa has the outer wall nearer the mid-line than the outer wall of the ganglionic fossa, instead of further from it, as in the majority of the bony fishes.

The resemblance to the teleostean arrangement extends to the otocrane. The posterior ampullary recess, the meeting place of posterior and horizontal semicircular canals, lies to the outer side of the fore end of the postotic portion of the side wall of the cranium. The anterior ampullary recess is confluent with a large fossa utriculi, which in turn is not separated from an arcuate fossa, there being none such formed. In the teleostean skull, it will be remembered, the anterior semicircular canal, not enclosed in a bony canal, lies among the loose connective tissue mesial to and slightly behind the arcuate fossa, whilst the utriculus is packed in the same tissue behind and below it. In *Neoceratodus* a large cavum utriculi is formed between the basal and otic roots of the quadrate, with the ascending root in front. The anterior vertical semicircular canal tunnels the cartilage of the roof of this cave and opens into it against the anterior wall. Immediately to the inner side of this opening is a ridge of cartilage which strongly recalls the anterior boundary of the arcuate fossa of the teleosts, and would seem to support a suggestion previously made, that the arcuate fossa, though not now accommodating the anterior vertical canal, was developed in relation to it (Kesteven, *loc. cit.*, p. 205).

[5] Kesteven.—Rec. Austr. Mus., xv, 1926, p. 203.

The two vertical semicircular canals lie just beneath the cartilage in the roof of the otocrane, and are visible through it. The horizontal canal lies at a lower level, lateral to the base of the triangle whose sides are the other two canals. By transmitted light this canal may be seen below and mesial to the sensory canal. The two vertical canals meet and open together in the roof of the otocrane in front of the posterior ampullary fossa.

The large cava sacculi lie mesial to the cava utriculi and at a lower level, encroaching on the cranial floor, just as so often occurs in the teleostean skull.

The Foramina and Canals in the Chondrocranium.

The large olfactory passages leave the fore end of the cranial cavity on either side of the vertical plate of the ethmoid cartilage, which, further forward, is uninterruptedly continuous with the nasal septum. This canal accommodates the olfactory lobes; its floor is slightly elevated above that of the fossa, whereon lie the lobes of the prosencephalon. At the anterior end of this fossa there is a little pit that apparently lodged a venous sinus of some size. I find that a groove leads from each of these little venous (?) fossæ mediad, to the posterior aperture of a canal which runs forward through the vertical plate of the ethmoid, and then divides into right and left branches, which open below the inner limit of the anterior margin of the floor of the olfactory passage. There are also two canals passing direct from the little fossa to this same anterior opening. This is the condition on the right side of the specimen; on the left the three canals have separate apertures close to one another along the margin.

The optic foramen lies at the angle between wall and floor of the prosencephalic fossa about the middle of the antero-posterior length thereof. A groove, which lodged the optic artery, leads back and mediad from this foramen to the internal aperture of the canal for the cerebral artery at the side of the pituitary fossa.

In the roof of the cranium directly above the optic foramen there is a fossa from which canals pass out right and left to open on the antorbital buttress just below where this merges into the horizontal roofing plate of the ethmoid cartilage.

The oculomotorius foramen is at the level of and just in front of the post-pituitary eminence.

I have been unable to detect any separate aperture for the exit of the fourth nerve.

A separate abducent canal is apparently present. In *Lepidosiren*, Bridge[6] describes the course of the superior palatine branch of the facial nerve, and on plate 28 in figure 6, he illustrates the inner aperture of the canal along which it passes, whilst in figure 3 he indicates the external aperture. Now in *Neoceratodus* I find the internal aperture of a canal (whose external aperture is placed just within the rim of the external foramen for the first branch of the fifth nerve) in just the position of the internal aperture of the canal for the palatine branch of the facial nerve illustrated by Bridge.

Notwithstanding the description of Bridge, I am of the opinion that we have here the abducent canal. To this conclusion I am forced by the facts that this canal reproduces with remarkable approximation the position of abducent the canal

[6] Bridge.—Trans. Zool. Soc., xiv, 1898, p. 348.

not only in *Amia* (Allis[7]) and most teleosts (*cf. Scomber*, Allis[8]), but also in the reptiles (Kesteven[9]) and some amphibians, *e.g., Siren* (H. W. Norris[10]). In some elasmobranchs the nerve takes a similar course to the orbit (*cf. Squalus*, Norris and Hughes[11]). When to these facts is added that this canal opens, not upon the base of the cranium, but on to the orbit, it would appear only reasonable to regard it as the abducent canal.

The trigemino-facialis fossa presents three apertures in its outer wall. Of these the first two open externally, one in front of and the other behind the ascending process of the quadrate, and, exactly as in the Amphibia, the former transmits the first branch of the trigeminal nerve, and the latter (foramen prooticum internum) the second and third branch of this nerve as well as buccal and ophthalmic branches and lateralis branch of the facial nerve. The third canal passes out and backward between the otic and basal roots of the quadrate and transmits the truncus hyomandibularis of the facial nerve.

The glossopharyngeus foramen perforates the side wall of the cranium just below the posterior ampullary fossa and appears externally on the side of the cranium lateral to the anterior end of the parabasal sulcus.

The vagus foramen is situated somewhat higher and a little further back than the last. This canal divides very soon into two. One branch, doubtless carrying the lateral line components of the nerve, turns dorsad and communicates by a groove on the back of the cranium with the posterior aperture of the lateral line canal. The other and larger branch passes out and ventrad as well as backward, becoming wider as it extends; it has two apertures placed close together below the hinder end of the parabasal sulcus. Bridge[12] states that in *Lepidosiren* the anterior cardinal vein emerges from the cranial cavity through this foramen. I believe that in *Neoceratodus* the vein which he thus designates leaves the cavity through a canal placed below and behind the vagus canal.

Turning now to the outside of the cranium, the optic foramen is found just behind the antorbital buttress. At the back of the orbit, at the junction of inner and posterior walls, and just above that little flange of cartilage which Bridge regarded as representing the palato-pterygoid, there is the common orifice of the oculomotorius and canal for the first branch of the fifth nerve. Immediately outside this is the tiny orifice of the abducent canal, and below it the opening of a communication with the parabasal canal. Lateral to these again is that anterior aperture of the parabasal canal which has been described as transmitting the ophthalmic artery. Above this last is the large aperture of the canal for the main mass of the nerves originating in the trigemino-facial ganglion, foramen prooticum externum. The external aperture of the canal for the truncus hyomandibularis facialis is placed above the body of the quadrate.

The jugular vein* and posterior carotid artery have impressed their track along the underside of the cranium in the form of a deep sulcus, which is situated below the external apertures of the ninth and tenth nerves, and which is continued forward as a closed canal between the basal process and ascending

[7] Allis.—Journ. Morph., xii, 1897, p. 517.
[8] Allis.—Journ. Morph., xviii, 1903, p. 237.
[9] Kesteven.—Journ. Anat., lii, 1918, p. 458.
[10] Norris.—Journ. Morph., xxiv, 1913, p. 262.
[11] Norris and Hughes.—Journ. Comp. Neurol., xxxi, 1920, p. 313.
[12] Bridge.—Trans. Zool. Soc., xiv, 1898, p. 350.
* This is the "vena capitis" and "vena capitis lateralis" of Greil, Edgeworth, and Allis.

and otic processes of the quadrate; the resemblance which this canal and its contents bear to the conditions in the birds and reptiles leads one naturally to designate it parabasal canal (*vide* Kesteven[13]), and the sulcus may likewise be designated parabasal sulcus. The situation of the anterior opening of the canal has already been described. Besides the superior jugular vein, the sulcus and canal also carry the posterior carotid artery. Inside the canal the artery divides into its terminal cerebral and palatine arteries just as in the reptiles. The cerebral artery turns mediad through its own canal to enter the side wall of the pituitary fossa once more as in the reptiles, and, also with the same similitude, the palatine artery is continued forward immediately above the parasphenoid. There is, however, a larger terminal branch of the parabasal canal which runs straight forward to the anterior aperture already mentioned, and transmits a branch which may be termed the ophthalmic artery, and an equally large branch inclines dorsally to open into the foramen prooticum externum, transmitting orbital artery and vein. The anterior carotid is accommodated in a canal which runs parallel to, but below, that for the hyomandibular branch of the facial nerve. This canal communicates with the parabasal close to the departure of the canal for the cerebral artery, and there is probably an arterial anastomosis in this situation. Spencer's work[14] on the blood vessels of *Ceratodus* has been largely followed in this connection. Besides the larger branch above mentioned, there is a second much smaller communicating canal between the parabasal and the foramen prooticum externum. Just where the canal for the cerebral artery leaves that for the palatine there is a small communicating branch, which passes forward slightly laterad and dorsad to open just outside the common aperture of the canals for nerves III, IV, and V^1, and just behind this a short passage connects with the canal for the truncus hyomandibularis nervi facialis directly above it. This last appears just within the nerve canal as viewed from within the cranial cavity, and it is *more* than probable that we have here the canal for the palatine branch of the facial nerve which Bridge describes; its cranial opening is placed just lateral to the internal foramen for the abducent nerve. It is particularly interesting to compare the situation and contents of the fore part of the parabasal canal with the same structures in the reptiles. In both cases the carotid artery is joined, just before it branches, by the palatine branch of the facial nerve, which tunnels the side wall of the cranium to reach it, and after giving off the cerebral artery the terminal (palatine) branch of the vessel continues forward accompanied by the nerve, imbedded in the basis cranii. In the case of *Neoceratodus* the hinder part of the parabasal canal carries also the external jugular vein or a tributary thereof; this leaves the artery where that makes a slight bend mediad before giving off the cerebral artery, and continues straight forward.

Though it has not been possible to trace the nerves in question, there seems little doubt that the lateral line sensory canal which tunnels the attachment of the suprabranchial cartilaginous roof, carries the ramus lateralis accessorius, and that the facialis fibres of the nerve enter the canal from the foramen prooticum externum, whilst the vagus components enter from the back of the canal along the groove above mentioned as leading from the dorsal branch of the vagus canal

[13] Kesteven.—Journ. Proc. Roy. Soc. N.S.W., lix, 1925, pp. 108-123.
[14] Spencer.—Linnean Society of N. S. Wales, Macleay Memorial Volume, 1893, pp. 1-34.

to the hinder end of the sensory canal. There are a number of perforations in the roof of the sensory canal along its length. Bridge makes no mention of this canal in *Lepidosiren*, but the "schlafengrube" of Hyrtle is its posterior opening. The lateralis fibres of the vagus reach it through the perforation which leads from it to the under side of the cranium.

B. Comparative Review and Phylogeny.

The "elasmobranch" completeness of this chondrocranium would make the identification of certain areas and their comparison with the structures of other crania a difficult problem, were it not that in the other two recent Dipnoi the cranium is incomplete. Comparison of *Neoceratodus* with these enables us to arrive at a correct understanding of its parts. This understanding is further assisted by the consideration of the early stages in the development of all three chondrocrania.

Comparison of the cranium in its entirety can only be made with the chondrocrania of the Amphibia, although it presents resemblances in particular areas to those of the fishes and reptiles.

If the chondrocranium of *Lepidosiren* or *Protopterus* be compared with that of one of the urodeles (*e.g.*, *Triton*), it will be found that, part for part, there is a very close resemblance as far forward as the planum internasale, except for the large lateral cranial fenestra, the large cava sacculi, the absence of external apertures to the otocrane, and the separate exit of the ninth nerve. In these features the dipnoan crania resemble those of the fishes.

In the urodeles, as the planum internasale is approached, the trabecular crest is rapidly reduced in height, and from here forward the trabeculæ are flattened in the horizontal plane; beyond the "planum" they separate again and are continued forward, the trabecular cornua forming the outer angle of the front margin of the solum nasi. In the fishes also it would appear that always the trabecular cornua lie below the nasal sacs.

In early stages in the two Dipnoi, on the other hand, the trabecular crest continues undiminished in height for a little distance forward of the posterior margin of the planum internasale, and then gives off antorbital processes. The "planum" itself is tilted dorsad so that its anterior margin is actually higher than the dorsal margin of the trabecular crest. For a short interval it appears that the crests become separated and are then reunited *above* the nasal sacs; from the resulting median strip of cartilage the internasal septum hangs down. To either side of this cartilage the fenestrated tectum nasi is attached. Bridge[15] has identified two spurs at the anterior margin of this tectum as "trabecular cornua," and he compares them with the trabecular cornua of *Bufo* as described by Parker. But the trabecular cornua of the anurous amphibians, like those of the urodeles, lie below the nasal sacs, not above them.

The origin of the antorbital process from the trabecular crest in *Protopterus* was noted by Winslow[16] as a feature wherein it differed from all other forms studied by him.

In a number of the Urodela and Anura, if not in all, from the front margin of the planum internasale or mesethmoid plate there rise two cartilaginous plates,

[15] Bridge.—Trans. Zool. Soc., xiv, 1898, p. 340.
[16] Winslow.—Tuft's College Studies, 5, 1898, p. 192.

which may or may not extend forward along the inner margin of the trabeculæ in front of the "planum." These, with further growth, give rise to the tectum nasi and the upper part of the lateral wall. The prominent posterior part of this wall was termed the "lamina cribrosa" by Winslow (*loc. cit.*) and the "planum antorbitale" by Gaupp.[17]

On comparing these structures with those anterior to the ethmoid plate in *Lepidosiren* and *Protopterus*, one is compelled to conclude that they are homologous, and that the antorbital process of these forms is really a modified planum antorbitale.

Since there is no trace of any solum nasi in *Neoceratodus*, it appears that in the recent Dipnoi the whole of the structures developed in other vertebrata directly from the trabeculæ in front of the planum internasale below the nasal sacs are not represented.

There can be no doubt that, in all its parts, the quadrate of the Dipnoi is completely homologous with that of the Amphibia; to this conclusion we are forced by the relation of the three points of attachment to the areas of the cranium, and to the branches of the fifth and seventh nerves. The ascending process is attached to the trabecular portion of the cranium between the first branch of the fifth, and second and third branches, and the buccal and ophthalmic branches of the seventh. The otic process is attached to the otocrane laterally and anteriorly, behind the last nerves and above the hyomandibular branch of the seventh. The basal process is attached to the anterior end of the parachordal region of the skull basal plate, and is crossed superiorly by the last nerve mentioned.

With the single exception of *Ichthyophis* (Edgeworth[18]), these relations are maintained throughout the whole of the Amphibia and, if the epipterygoid of the reptile be the ascending process of the Amphibia, throughout the Reptilia as well. Relationships persistent through two whole classes must surely be of fundamental phylogenetic significance, and may confidently be made use of for the purposes of studying the autostylism of those few elasmobranchs and bony fishes which present the feature. The autostylism referred to is that of the hinder quadrate end of the subocular arch, not the anterior attachment to the planum ethmoidale, or a process thereof.

As far as I have been able to ascertain, autostylism among the bony fishes is confined to the Mormyridæ, but before proceeding to the examination of its form in these fish it were well to note and consider a statement by Edgeworth[19] that the Dipnoi are more primitive than the Amphibia in the more anterior attachment of the basal process of the quadrate.

This statement is fairly certainly based on the observation of Agar[20] that the basal process of *Protopterus* is attached to the trabecular, and his own many observations that in the Amphibia the attachment is to the basal plate or floor of the otic capsule.

Now Agar's identification of the trabecular, as distinct from the parachordal region of the chondrocranium, is clearly based upon the relation to the fore end

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[17] Gaupp.—*In* Hertwig's Handbuch der vergleichend. u. experim. Entwicklungslehre, iii, Jena, 1905.

[18] Edgeworth.—Journ. Anat., lix, 1925, pp. 225-264.

[19] Edgeworth.—Journ. Anat., lix, 1925, pp. 225-264; *loc. cit.*, lx, 1926, pp. 298-308.

[20] Agar.—Trans. Roy. Soc. Edinb., xlv, 1906, pp. 49-64.

of the notochord. Such a standard of identification is, of course, not open to objection, but it is an arbitrary one. Conclusions as to what is or is not primitive based on this standard are liable to lead us astray. Thus the notochord in the Dipnoi does not extend so far forward as it does in the Amphibia, and much of the cranial axis that in the Amphibia is regarded as parachordal is in the Dipnoi regarded as trabecular; for example, the trigemino-facialis fossa situated well behind the pituitary region in the latter is deemed to be trabecular, as also is the region of the skull base behind the emergence of the roots of the fifth and seventh nerves, whilst the same regions are deemed to be parachordal in amphibians and all those vertebrates in which the notochord extends forward up to or beyond them. There is another method of determining the trabecular and parachordal regions of the primordial skull rudiments, which regards the trabeculæ as lying on either side of the infundibulum. If this standard of measurement be adopted (and it seems the more useful in view of the variable length of the notochord, and of the trabeculæ and parachordal rudiments), then we can find no differences in the points of attachment of the basal processes of the Dipnoi and Amphibia.

If we are to regard the basal processes of the Dipnoi as having attachment to the trabeculæ and therefore as being more primitive, then, since the identification of the trabeculæ is determined by the length of the notochord, it would seem that we must regard the short notochord as the more primitive, surely an untenable position.

Assheton[21] has described the development of the chondrocranium of *Gymnarchus niloticus*, one of the Mormyridæ. He states that "the palato-pterygo-quadrate bar articulates, but is not fused with, the skull in the anterior part of the auditory capsule, just under the horizontal canal" (p. 406), and this is quoted by Edgeworth[22] as evidence that Teleostomi are descended from autostylic and monimostylic ancestors. In the earlier part of the sentence quoted, Assheton describes the hyomandibular and palato-pterygo-quadrate as being no longer distinct, and his figures plainly show that it is the hyomandibular constituent of the composite bar that articulates as described.

Study of Assheton's description and drawings convinces that the autostylism of *Gymnarchus* presents no resemblance to that of the Dipnoi and Amphibia. Neither ascending, basal, nor otic processes are developed. Edgeworth's [23] description of the fate of the oto-quadrate cartilage in *Neoceratodus* might give rise to the belief that the hyomandibular may be regarded as being normally a contributor to the formation of the otic process, but as against this there is the mode of formation of the otic processes in the closely related *Lepidosiren* and *Protopterus* (Agar, *loc. cit.*). Moreover, the oto-quadrate cartilage is said to gain attachment to the base of the chondrocranium, whereas the definitive otic process of *Neoceratodus* is separated from the base of the chondrocranium by an appreciable thickness of cartilage, the basal process.

Among the Elasmobranchii, only the Holocephali are autostylic and monimostylic. The so-called otic process of *Heptanchus* and *Cestracion* articulates with a special postorbital process of the cranium and presents no relationships in common with the otic process of the quadrate of the Dipnoi and amphibians,

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[21] Assheton.—*In* The Work of J. S. Budgett, pp. 293-421, 1907.
[22] Edgeworth.—Journ. Anat., lix, 1925, pp. 225-264.
[23] Edgeworth.—Quart. Journ. Micro. Sci., lxvii, 1923, pp. 325-368.

nor does the quadrate of these forms present anything homologous with the ascending and basal processes of those others.

Allis[24] writes: ". . . . the efferent mandibular artery of *Ceratodus* . . . . is shown, in Greil's figures of this fish, . . . running upward and forward posterior and then mesial to the entire quadrate. This relation of the artery to the otic process would seem to definitely establish that the otic process of the Notidanidæ is the homologue of the otic process of *Ceratodus*, as de Beer concludes, and that both these processes are the homologues of the metapterygoid processes of the Holostei and Teleostei."

The vessel referred to can only be the hyoid artery and anterior carotid of Spencer.[25]

Kellicott[26] has stated that ". . . . the Elasmobranch similarities (of the vascular system of *Neoceratodus*) seen in the arrangement and distribution of the carotid arteries and the connection between the anterior carotid artery and the vessels of the hyoid arch, ... all prove to be in the nature of parallelisms . . . ." when their development is worked out.

This being so, Allis is on very unsafe ground in attempting to defend any homology based on the relation of the vessels.

In the Holocephali the whole length of the subocular arch is rigidly united to the cranial axis along the base thereof. The quadrato-meckelian joint is thrown very much further forward than in any of the other forms, and from the back of the quadrate a horizontal sheet of cartilage extends to behind the otocrane. This sheet becomes somewhat narrowed as it passes back, and opposite the foramen for nerves V and VII a triangular vertical sheet, the back wall of the orbit, rises from its upper surface. The base of this triangle is attached to the outer and anterior aspect of the otocrane. A search here for the homologues of the three processes of attachment of the dipnoan quadrate is vain; no part presents the relations to nerves and skull regions that any one of the three processes presents.

The autostylism of the Holocephali is in no way homologous with that of the Dipnoi and Amphibia, though it may be a primitive form of it.

In their autostylism and in the form of the nasal roof the chondrocrania of the Dipnoi are definitely amphibian in character. In the form of the otocrane, with its large cava sacculi, absence of external fenestræ and large internal lateral cranial fenestra, and in the possession of a separate foramen of exit for the ninth nerve, they are just as definitely piscine, whilst in the complete suppression of all but the quadrate portion of the subocular arch the Dipnoi resemble, but outstrip, the reptiles.

Among recent writers on the origin of the Tetrapoda there are two somewhat opposing views; on the one hand it is believed that the Dipnoi and Amphibia, along with other lower vertebrata, have been evolved from autostylic and monimostylic ancestors (Edgeworth[27]), and on the other that the Amphibia were derived from the crossopterygian fishes without the intervention of any dipnoan-like form (Watson,[28] Gregory[29]).

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[24] Allis.—Journ. Anat., lxiii, 1929.
[25] Spencer.—Linnean Society of N. S. Wales, Macleay Memorial Volume, 1893, pp. 1-34.
[26] Kellicott.—Mem. New York Acad. Sci., ii, 4, 1905, pp. 135-249.
[27] Edgeworth.—Journ. Anat., lix, 1925, pp. 225-264.
[28] Watson.—Mem. Proc. Manch. Lit. Phil. Soc., lvii, 1, 1912.
[29] Gregory.—Ann. New York Acad. Sci., xxvi, 1915, pp. 317-383.

The variety of the autostylic monimostylic and semimonimostylic conditions, and the absence of homology in their various modes of attachment to the skulls which is manifested by the bony and cartilaginous fishes, appears to me as evidence that these are adaptive modifications, and that such resemblances as they happen to present are purely analogous. From this I would conclude that they are descended from streptostylic ancestors.

From the peculiar combination of piscine and amphibian characters in the dipnoan chondrocranium I would conclude that the Dipnoi probably approach closely to the form of the common ancestor of the two groups (Dipnoi and Amphibia). I have elsewhere shown[30] that there is a good deal of other evidence indicating their common origin.

PART II.

THE IDENTITY OF THE COVERING BONES AND THEIR BEARING ON THE ORIGIN OF THE TETRAPODS AND OF THE DIPNOI.

(Figures 5 and 6.)

A.—DESCRIPTION OF THE COVERING BONES.

The large parasphenoid needs no particular description. My specimens were all truncated in front of the posterior end of the bone, and my figure indicates the position of only so much as was preserved in the specimen illustrated (Fig. 5).

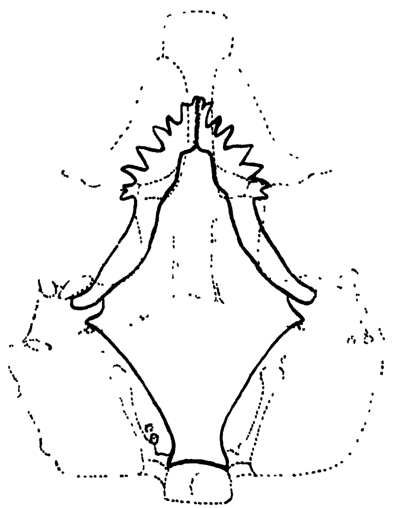

Fig. 5.—Slightly schematic presentation of the dorsal cranial and periotic bones of *Neoceratodus forsteri*.

The bones on the base of the skull on either side and in front of the parasphenoid have been regarded as composite bones and designated pterygo-palatines, the designation conveying the generally accepted interpretation of their composition. With the designation and the interpretation it conveys it appears only reasonable

[30] Kesteven.—REC. AUSTR. MUS., xviii, 1931, pp. 167-200.

to agree. We may recognize palatine and pterygoid portions of the bone and an ascending process of the former portion. The palatine is that portion of the bone on which the large composite tooth is set; the pterygoid portion lies behind it.

The palatine portion lies against the basis cranii beneath the olfactory passages and the antorbital buttress, with the cusps of the tooth standing out beyond the cartilaginous basis. The pterygoid presents a free semilunate area of its dorsal surface immediately behind the antorbital buttress; for the rest, the dorsal surface lies against (1) the outer edge of the under surface of the cranium at the site of the prosencephalic fossa, (2) the under surface of that little flange of cartilage which Bridge regarded as representing the pterygoid process, and (3) the inner aspect of the body of the quadrate. The two palatine portions meet in a median suture and that which is presumably the posterior margin of each palatine bone is in sutural contact with the corresponding half of the fore end of the parasphenoid bone. The inner margin of the pterygoid portion on each side sutures with the outer margin of the fore end of the parasphenoid; the quadrate process makes no contact with any bone.

The ascending process of the palatine lies against the side wall of the cranium in front of the antorbital buttress and behind the anterior aperture of the olfactory passage. This process is attached to the outer edge of the palatine rather nearer to the front end than the middle of the length, by a small round pedicle, and expands as it rises. The front corner of its dorsal edge is definitely sutured to the posterior median dorsal covering bone by two or three little digitations. For the rest, except for the pedicle of attachment the process has an unfinished appearance and lies imbedded in a mass of fibrous tissue, wherein is also imbedded the descending process of the "ectethmoid," with which process it sutures.

The large size of this ascending process relative to its pedicle of attachment gives the impression that it has an origin independent of the palatine bone; if this be so it will have to be considered in reviewing the identification of the "ectethmoid."

The prevomers are but two small plates placed on the side of the inferior margin of the septum nasi a short distance in front of the palatine bones. The inferior surface of each is entirely covered by the elongated, slightly curved, cutting vomerine tooth. These bones make no contact with any other bone.

There is in *Neoceratodus* the same number of dorsal covering bones as in the other two Dipnoi, and in the following description the designations of Bridge[31] for the bones in *Lepidosiren* will be used, but in the comparative review of these bones another interpretation of their homologies is offered, based on a comparison with the covering bones of osteolepid fishes and primitive stegocephalians.

The dermal ethmoid lies in contact with the dorsal surface of the cranium above the olfactory passages. The posterior margin of the bone lies above the antorbital buttress, the anterior above the posterior margin of the anterior nares. It is sutured behind to the fronto-parietal and dermal ectethmoids.

The fronto-parietal is in contact with the flattened dorsal area of the cranium behind the antorbital buttresses, with the sagittal ridge which extends back from that area, and with the dorsum of the cranium behind and between the site of the posterior vertical semicircular canals. Its outer margin is overlapped by the

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[31] Bridge.—Trans. Zool. Soc., xiv, 1898, pp. 325-376.

inner margin of the dermal ectethmoid. Between the site of the posterior semicircular canals, and the flattened area in front of the antorbital buttress, the bone is separated from the cranial roof by the origin of the muscles of mastication, except for the very narrow strip in contact with the sagittal ridge. A little spur extends downward and out on either side just in front of the antorbital buttresses to make sutural contact with the ascending process of the palatine.

The dermal ectethmoid makes true sutural contact with the fronto-parietal for the anterior third of their contiguous margins, but overlaps that bone in a sutura notha for the remainder of the length. The descending antorbital process of the bone makes true sutural contact with the ascending process of the palatine and effects a synchondrotic union with the upper surface of the palatine itself just behind that process. The ascending process of the palatine and descending process of the dermal ectethmoid together constitute a nearly complete bony anterior wall to the orbit. Posteriorly the very thin, almost membranous, expansion of this bone is in contact with the dorsum of the cranium lateral to that posterior portion of the fronto-parietal which also is in contact with the cranium; for the rest, the dermal ectethmoid forms a partial roof for the orbit and a covering to the muscles of mastication lateral to the fronto-parietal and mesial to the

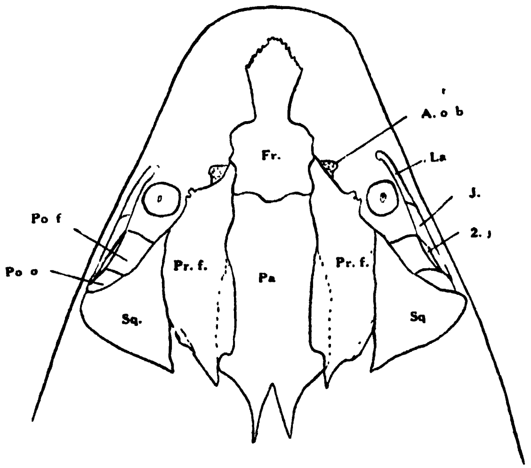

Fig. 6.—Outline of ventral aspect with bones in place.

squamosal bone. In front of the fronto-parietal, the dermal ectethmoid forms a sutura notha with the dermal ethmoid on each side near the posterior margin thereof.

The squamosal bone presents two portions for description: The dorsal squame, triangular in outline, lies in the same plane as the fronto-parietal and dermal ectethmoid, and completes the roof of the muscles of mastication. The descending process is a splint, which is expanded and hollowed out inferiorly to fit the quadrate cartilage just above the articular surface, and is continued up along the outer edge of that cartilage; bending backward it lies along the thickened outer edge of the cartilaginous suprabranchial roof for a short distance, then, lifting free of the cartilage, it joins the outer angle of the dorsal squame, thickening the outer margin of that squame for a short distance before it terminates. The suture

between the dermal ectethmoid and the squamosal is a squamous suture, the dermal ectethmoid overlapping the more median bone. Günther[35] designated the descending process, os quadratum, and the squamous portion of the bone, tympanic lamina, and in his Figure 1, Plate xxxv, presents a very correct picture of all the bones which he shows in this side view of the complete skull.

No two writers have described the circum-orbital bones of *Neoceratodus* alike, and I find that the specimen I have dissected presents a condition quite different to any heretofore described.

Including the little bone which Huxley[36] described and indicated with the letter "E," there are in my specimen six of these bones (Fig. 8*a*). Commencing above behind the eye there are two attached respectively to the dermal ectethmoid and the squamous portion of the squamosal and to one another by their contiguous margins. These may be known for the present as the two superior postorbital bones. The inferior postorbital bone lies below these and is attached to the lower edge of both of them. Its hinder margin is just in front of the descending process of the squamosal, separated from and attached to it by connective tissue. The posterior subocular bone is attached to the lower edge of the inferior postorbital but extends forward beyond it under the eye. Its posterior margin is attached by fibrous tissue to the lower end of the descending process of the squamosal, and it extends from this point forward and inward (mediad), providing a weak bony margin to the hinder part of the upper jaw. Where this bone lies below the postorbital bones its upper edge is directly above the lower, but as it passes beneath the eye the upper edge is turned outward slightly, so that the bone comes to lie obliquely beneath the eye, forming an incomplete floor which slopes inward and downward. The anterior subocular bone is attached to the fore end of the last bone. Their margins of attachment are parallel, but this bone rapidly bends into the vertical. Its anterior end is attached to the antorbital buttress by a mass of strong fibrous tissue.

The sixth periotic bone lies over the descending process of the squamosal with its anterior margin attached to the posterior margin of the inferior postorbital bone. All of these bones, except the hinder of the two superior postorbitals, lie more deeply than the larger covering bones, separated from the deep layer of the skin by an appreciable thickness of tough fibrous tissue, by which they are bound together.

The operculum is firmly bound to the postero-lateral margin of the squamous portion and descending process of the squamosal bone, and has the sub-operculum bound to its lower margin.

All six periotic bones lie deeper than the sensory canals, which, in this region, appear to have imperfectly ossified walls, for the knife commonly "grits" when cutting through them. This leads to the belief that none of the bones I have just described corresponds with any of the three, four, or five subocular bones previously described (except Huxley's bone "E"), all of which are said to have been tunneled by sensory canals. All are quite strong squames of bone, and I am at a loss to understand how it comes about that they could have been missed by previous workers; this made me hesitate in coming to the above belief, but quite definitely they are none of them tunneled by sensory canals.

[35] Günther.—Roy. Soc. Lond. Phil. Trans., clxi, 1871, pp. 511-571.
[36] Huxley.—Proc. Zool. Soc. Lond., 1876, p. 37, fig. 7.

B.—Comparative Review and Phylogeny.

1. The Bones of the Palate.

The posterior portion of the pterygo-palatine bone of *Lepidosiren* is undoubtedly the pterygoid bone.

The pterygoid bone of the Dipnoi is developed as a covering bone on the base of the cranium, and in the recent forms shares in the formation of the cranial wall and floor, though not appearing internally.

The pterygoid bone of the recent Amphibia is developed as a splint on the pterygoid portion of the primitive subocular arch.

Both are ectochondral membrane bones, but there the resemblance ceases, and I am utterly unable to persuade myself that it is reasonable to regard as homologous bones developed in relation to such fundamentally different structures.

On the other hand it seems obvious that the pterygoid bones of the Dipnoi, embolomerous Amphibia and cotylosaurian reptiles are homologous.

Since the Dipnoi have both pterygoid and parasphenoid well developed it may appear that I have been in error in deriving the reptilian pterygoid from the parasphenoid bone. This question is returned to on a later page.

Watson's[34] proposal to arrange the palates of *Loxomma*, *Eryops*, *Rhinesuchus*, *Capitosaurus* and *Cyclotosaurus* in series and derive the pterygoids of the capitosaurian palates, and through them those of the Branchiosauria and Batrachia Salientia from the first of the series, is certainly enticing, but it is convincing only if one completely neglects the genetic relationships italicized above.

The form which the pterygoids present in the Dipnoi is the only form which is present in the most primitive amphibians and reptiles, and in all of them it is applied to the basis cranii, taking more or less share in the formation of the floor and side walls of the cavum cerebri.

Without exception the pterygoid of the recent Amphibia is developed in relation to the pterygoid process of the quadrate.

Comparing the palates of the capitosaurian amphibians with those of the Urodeles, impressing *Batrachosuchus* to complete the set, one finds a series which connects by easy gradations the palates of *Eryops* as the one extreme and *Branchiosaurus* or *Rana* as the other. There will be found in this series of palates no such marked break as is present between the embolomerous palate and that of *Eryops*.

On the other hand it is possible to arrange a series of palates commencing with the Dipnoi, and passing through the embolomerous, *Loxomma*, type to *Seymouria* and the chelonians, and thence to all or any of the recent or fossil reptilian types, and again the series will present no discontinuity. There is no need to depart from the chronological order in arranging these series.

On comparing the palate of *Batrachosuchus* with that of the Urodeles, *e.g.*, *Sieboldia* or *Menopoma*, one finds so complete a resemblance between the pterygoids of the two forms that one must conclude that they had a like genesis; that is to say, both were developed in relation to the pterygoid portion of the subocular arch. Now we may pass to the other rachitomous and stereospondylous amphibian palates, and, step by step, from palate to palate, assure ourselves that the pterygoids in all had a like genesis. In all these cases the pterygoid articulates with the

[34] Watson.—Journn. Anat., liii, 1919, pp. 239-240.

edge of the covering bones of the basis cranii, at the side thereof. The bone is also applied to the underside of the quadrate and the base of the otocrane where the quadrate roots find attachment, but in no case is the bone applied to the base of the cranium itself.

Returning again to the Dipnoi, we have the evidence of embryology that there can have been no relation to the subocular arch in the genesis of the pterygoid. Unless the published descriptions and drawings of the embolomerous palates are misleading, the pterygoids are, as in the Dipnoi, applied to the basis cranii; there is, therefore, reason to suppose that they were genetically related thereto as covering bones.

There is conclusive evidence in the development of the pterygoids of the Urodeles that the relation to the side of the basis cranii is secondary. It will be remembered that the bone first appears in relation to the pterygoid process, that it grows backward, acquiring relationship to the quadrate and still later to the base of the otocrane and sphenethmoid region of the cranial axis. In the anurous Batrachia there is never any relation to the basis cranii; on the other hand the relation to the quadrate is apparent relatively earlier than in the Urodeles.

In passing, it is of interest to note, though a basipterygoid process has been described in *Eryops* and some other rachitomous amphibians, this is only a local broadening of the basisphenoid behind the prootic fissure, and therefore well behind the pituitary fossa. From this it follows that the so-called basipterygoid process is not homologous with that of the reptiles, which is situated in front of the incisura prootica and almost under the pituitary fossa.

From the foregoing facts it is to be concluded that the pterygoid of the Amphibia generally is not homologous with that of the reptiles, birds, and mammals, nor with that of the primitive embolomerous Amphibia.

A difficulty which stands in the way of the acceptance of this idea is presented in the question—if the pterygoid of the embolomerous Amphibia is not represented by the similarly named bone in the rest of the Amphibia, what represents it in the palate of these creatures? Apparently there is no trace of it, but why?

The answer to this question may perhaps be introduced by another—What has become of the parasphenoid in the higher tetrapods? The bone is well developed in the fishes, Dipnoi and most Amphibia; how comes it, then, that there is no trace of it, except perhaps a persistent anterior piece, the vomer, in all the other forms?

It would seem that in the Dipnoi we are presented with a condition near the dawn of the pterygoid of the higher tetrapods, and that in the Embolomeri and Cotylosauria we see a further stage in its evolution. The variety of palates of the branchiosaurian type already known from the Lower Permian and Upper Carboniferous must surely indicate that the group had its origin at an earlier time, so that, although the only amphibian type as yet known from the Lower Carboniferous is the embolomerous, there is every reason to believe that the other type must have been contemporaneous with it.

The Embolomeri present in the skull so many reptilian features that there can be no doubt that they are representatives of the group which stood in the direct line of the descent of the reptiles.

Since there is strong evidence that the typical amphibian as well as the "reptilian" amphibian palate existed side by side in Lower Carboniferous times, we must hark back for the ancestors of both.

That early common ancestor doubtless had a complete subocular arch, palato-pterygo-quadrate; for we find evanescent traces of it in the life history of the Dipnoi, and the more or less complete arch in the Amphibia, excluding, probably, the Embolomeri. One visualizes this ancestor as having been dipnoan-like in being monimostylic and autostylic, and in the possession of three basal covering bones (the parasphenoid and paired pterygoids); amphibian-like in the possession of a complete subocular arch with investing bones; fish-like in the possession of reduced (?) hyomandibular and opercular elements.

From this group there resulted, on the one hand the rapidly evolving stock from which there was derived the Dipnoi, Embolomeri, and the reptiles, and on the other hand the more static branch which, retaining the complete subocular arch, yielded only the rest of the Amphibia.

It is probable that the primitive ectochondral covering of the basis cranii was a single continuous plate of bone as in the fishes and the great majority of the amphibians, the parasphenoid bone. If in the Dipnoi in place of three bones there were but one, developed from three centres which fused, there is no doubt that we should all agree in designating the bone parasphenoid, but the three centres do not fuse and we find parasphenoid and paired pterygoids. In the Embolomeri and primitive reptiles we see the central portion of the parasphenoid more and more reduced, till, as pointed out by Broom, it is reduced to the vomer of the higher reptiles and the mammals.

Whilst it is possible that the pterygoid bones of the Dipnoi arose as new structures, and not from the fragmentation of the parasphenoid, it is quite obvious that they have no relation to a cartilaginous pterygoid process, for none such is developed in the Dipnoi. It follows that the bone cannot be homologous with the pterygoid bone of the majority of the Amphibia. On the other hand it is homologous with the pterygoid bones of the Embolomeri and the reptiles and the mammals.

Watson[35] has stated: "The vast majority of these amphibia, including the latest and most typically amphibian, retain a typical ectopterygoid, so that it is quite impossible for this bone to be the homologue of the amphibian pterygoid." Separated from its context this becomes ambiguous. The contention was that I had been wrong in arguing that the reptilian ectopterygoid is the homologue of the amphibian pterygoid, because quite a number of stegocephalians possess an ectopterygoid.

The contention fails unless it be proven that the amphibian os transversum is homologous with the reptilian bone of the same name. It appears never to have been noticed that among the recent Amphibia two bones, clearly not homologous, have been designated "palatine." Of the two bones that which has been so designated in the Urodeles appears to be the homologue of the palatine of the Stegocephalia. The palatine of the Branchiosauria and anurous Amphibia, on the other hand, situated as it is behind the internal nares, is the homologue of the os transversum of the Stegocephalia and the caecilians. There can be no doubt that it is homologous with the "palatine" of *Ichthyophis*, and this form stands as definitely intermediate between the Anura and the Stegocephalia.

Ichthyophis is also of interest as presenting the reduced amphibian pterygoid in the form and situation of the reptilian os transversum.

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[35] Watson.—Journ. Anat., liii, 1919, pp. 239-240.

2. The dorsal covering bones and the periotic scutes.

(Figures 6 and 8*a*.)

Omitting for the present the series of periocular bones, there is in *Neoceratodus* the same number of bones as in the other two recent Dipnoi, and, as their relations are in most respects very similar, it was taken that they might be regarded as homologous throughout. The application of the same names to the bones in all three, of course, involves the acceptance of this idea, but a statement by Bridge seems to indicate the need of a re-examination of the position, at least in respect of certain of the dorsal covering bones. The statement is as follows: "If the 'scleroparietal' (dermal ectethmoid) of *Ceratodus* is a 'tendon-bone,' it probably has no counterpart in any fossil Dipnoid; and as the fronto-parietal of *Protopterus* and *Lepidosiren* is situated internal to the jaw muscles, which could scarcely have been the case with any of the cranial plates of *Dipterus* and its allies, the same conclusion may be suggested with regard to this bone" (Bridge[36]). Now, if the latter part of this statement holds true, then also we cannot regard as homologous the fronto-parietals and squamosals of *Neoceratodus* and the other two recent Dipnoids, because in the former they are situated external to the muscles and in the latter they are covered by the same muscles.

A comparison of the fronto-parietal and squamosal of *Neoceratodus* with those of *Lepidosiren* reveals at once that in certain parts of the bones there is complete similitude. The descending process of the squamosal of *Neoceratodus* corresponds absolutely with that portion of the bone in *Lepidosiren* which is applied to the quadrate cartilage. Again, in both the fore end of the fronto-parietal is applied to the dorsal surface of the ethmoid roofing cartilage, and sutures with the hind end of the dermal ethmoid.

An almost parallel condition is presented by the parietal and squamosal bones in certain of the chelonians. In *Chelonia* the parietal bone contributes to the formation of the cranial wall, and also develops a large temporal flange which contributes largely to the roof of the temporal fossa. In *Chelodina* the cranio-mural portion of the bone is more extensive, and there is no temporal roofing plate. In *Chelonia* the squamosal bone is applied to the upper surface of the quadrate and here contributes to the wall of the tympanic cavity; it further expands upward and medially to contribute to the side wall of the temporal fossa. In *Chelodina* the temporal roofing plate is not developed. The examples chosen are not unique, but are exemplary of whole groups throughout which the bones are very correctly regarded as entirely homologous.

Though the parallel is not absolute it is sufficiently close to justify us in regarding the two bones as homologous in the three recent Dipnoi.

Like that of *Ceratodus*, the dermal ectethmoid of *Lepidosiren* is articulated or sutured to the ascending process of the palatine bone, and forms the dorsal margin of the orbit, lying beneath the skin. There can be no reason to doubt that we have the same bone to deal with in both cases.

Since we may rest assured that all the bones in the three recent Dipnoi are homologous, either of the two forms which most of these bones present may be used for purposes of comparison with other animals.

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[36] Bridge.—Trans. Zool. Soc., xiv, 1898, p. 367.

The terms dermal ethmoid, dermal ectethmoid, and fronto-parietal convey no ideas of serial homology. They are, therefore, unsatisfactory designations unless it can be shown definitely that they are not serially homologous with any bones in the fishes or amphibians.

It is quite clear that the recent Dipnoi present a skull pattern dorsally that had no representation among the early fossil forms. The outstanding modification that is observed is the reduction in the number of plates. Now, whilst it would be foolish to attempt to derive the dorsal skull pattern of the fishes or Amphibia from that of the recent Dipnoi, it is not unreasonable to assume that the same force which brought about the reduction in the number of plates and increase in size of the remainder, acted on the Dipnoi in the same manner as it acted on the fishes or amphibians. If from a comparative review we conclude that the dorsal covering bones of the Dipnoi are similar to those of primitive fish or amphibian, then we may regard the bones as homologous.

In the first place it is desirable to assure ourselves that the squamosal is correctly named.

Thyng[37] studied the development of the squamosal bone in the mammals and Urodeles, and then carefully compared his findings with the conditions in the adult crania of the stegocephalians and primitive reptiles. He concluded that the squamosal bone is essentially a bone developed in close association with the quadrate, and that it overlies the otic capsule. The relation which it commonly acquires with the parietal is to be regarded as secondary to these other features. Among the dorsal skull patterns which he illustrates is that of the Rachitome *Chelidosaurus*. Gregory[38] reduces Embleton and Atthey's illustration of the dorsum of the embolomerous *Loxomma* to simple lines, and letters the bones. These two temnospondyline skulls are remarkably similar, and Gregory's identification of the squamosal is the same as Thyng's. He also adopts Thyng's designation "supratemporal" for the bone between the squamosal and the parietal. Watson[39] states that in *Loxomma* the pterygoid ". . . . unites with the squamosal *to form a floor to the otic cavity*. . . ." This is quite incomprehensible; such a condition would be absolutely unique, and it is probable that the bone which the pterygoid meets in this situation is a prootic ossification.

Thyng's definition of the squamosal bone may be accepted. We find that the squamosal of *Lepidosiren* complies with this definition in its relation to the quadrate and to the otic capsule, and it is impossible to regard the squamosal of *Neoceratodus* as other than homologous with that of *Lepidosiren*. There can be no doubt that the squamosal of the Dipnoi is completely homologous with the similarly named bone in the temnospondyline amphibians.

The dermal ethmoid is certainly placed too far back to permit of its being regarded as representing the nasal bones of either the crossopterygian fishes or the temnospondyline Amphibia. On the other hand, there can be no valid objection to regarding it as representing the fused frontals. Similarly, it is reasonable to regard the so-called fronto-parietal as representing the fused parietals.

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[37] Thyng.—Tuft's College Studies, ii, 1906, pp. 35-73.
[38] Gregory.—Bull. Amer. Mus. Nat. Hist., xlii, 1920, pp. 95-283.
[39] Watson.—Mem. Proc. Manch. Lit. Phil. Soc., lvii, 1, 1912, p. 3.

In passing, it may be observed that the so-called pineal foramen of some of the osteolepid fishes is certainly placed a long way too far forward for it to have been a pineal foramen in the reptilian sense. May it have been a dorsal narial aperture comparable to that of the cyclostomata?

Bridge in his discussion of the identification of the dermal ectethmoid has fairly convincingly proven the correctness of his views, but his name for the bone is merely a synonym for prefrontal, that being the accepted designation today for every bone he compares it with.

The interpretation of certain of the periotic bones is made obvious by Gregory's[40] work on the evolution of the lachrymal bone. The lachrymal and jugal bones (la and j, fig. 1) are recognizable at sight, whilst that which I described as the inferior postorbital may confidently be identified as the quadrato-jugal. Of the two superior postorbitals, it may be that the anterior is the postfrontal forced down in front of the postorbital by the remarkable posterior expansion of the prefrontal.

The little broken squame behind the quadrato-jugal and postorbital may be a reduced interoperculum, though its position external to the squamosal is against this interpretation.

3. The Evolution of the Squamosal Bone.

(Figures 7 and 8.)

So far in the attempt to identify the bones of the dipnoan skull I have, as it were, looked forward, but if there be truth in the suggestion that these interesting forms approach closely to the common ancestor of themselves and the Amphibia, it should be possible to recognize some of these bones, probably in more primitive form, in more or fewer of the palæozoic fishes.

The ctenodont Dipnoi are found together with osteolepid crossopterygians in the Lower Old Red Sandstone of Scotland; both the Dipnoi and crossopterygians were, therefore, well established at that time. Any common ancestor must be sought in Silurian formations. The only ostracoderms that might have been considered in this connection are the Arthrodira, and they, apparently, are of no greater antiquity than the Dipnoi themselves. Among the elasmobranchs the Acanthodei alone present any features which entitle them to be regarded as possibly resembling the ancestors of the bony fishes, Dipnoi, and Amphibia, and it is particularly interesting to note that in the ichthyodorulite, *Onchus*, there is strong evidence that the group existed in Silurian times. This, of course, is also indicated by the fact that several genera from both the acanthodian families flourished in Lower Devonian times.

Even so, if it be regarded as proven that some such type as *Mesacanthus* stands close to the stem of all the higher vertebrates, we still cannot trace directly backwards the evolution of the cranial bones, for the record is far too incomplete.

Any attempt to homologize the cranial elements of the fishes, dipnoans, and amphibians can only be made under the assumption already made use of, that, having evolved from a common ancestor, the same inherited potential produced the same cranial elements in all.

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[40] Gregory.—Bull. Amer. Mus. Nat. Hist., xlii, 1920, pp. 95-283.

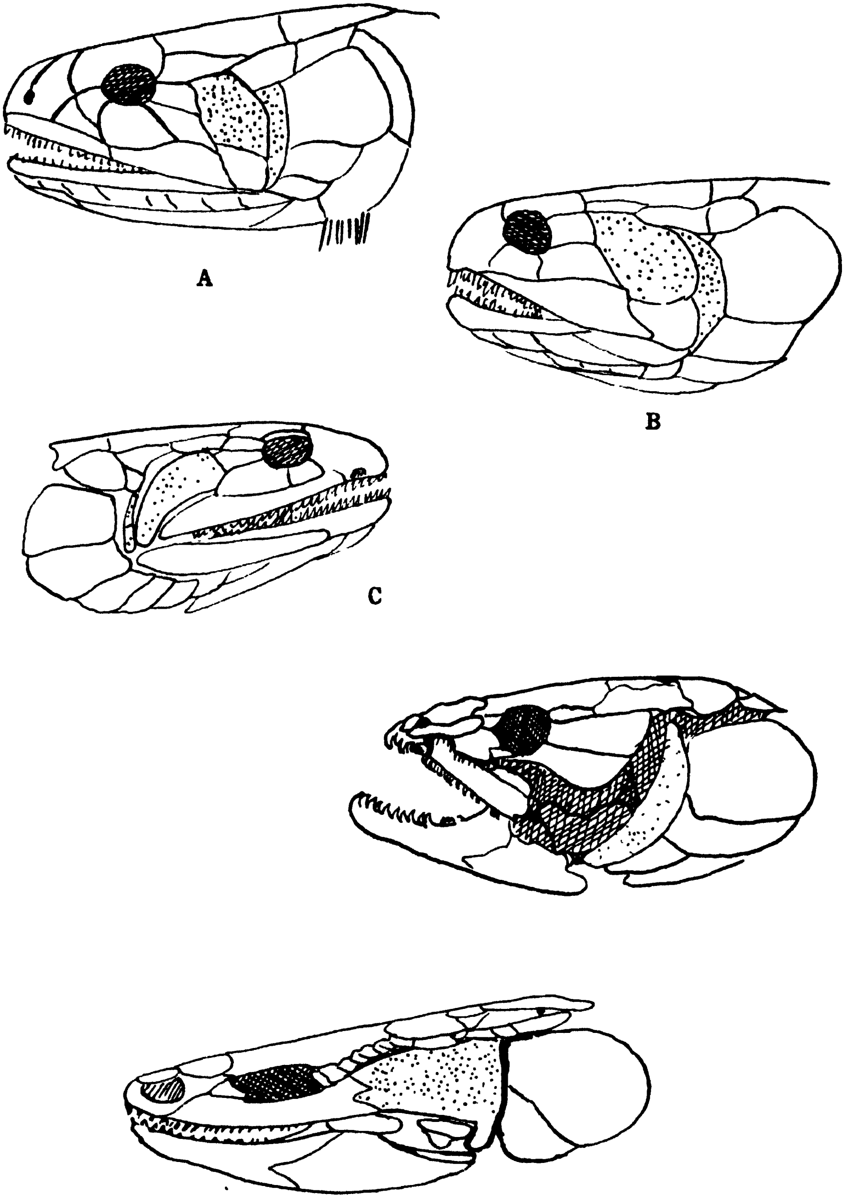

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Fig. 7.—The bones which are to be regarded as homologous with the tetrapod squamosal have been stippled. A, *Megalichthys* (after Wellburn from Gregory); B, *Rhizidopsis* (after Traquair from Zittel); C, *Osteolepis macrolepidotus* (from Gregory); D, *Amia* (from Allis); E, *Polypterus* (from Allis).

I have elsewhere offered[41] a mechanical explanation for the similarity in the fragmentation of the cranial wall, whilst Gregory[42] has offered a mechanical explanation for the fragmentation of the skull roof.

The importance of Gregory's postulate was realized by Adams,[43] who pointed out that it works out well in the case of *Polypterus*. It appears to me that the *potent mechanical factor in the evolution of the squamosal bones and in determining their position on the dorsum of the skull has been the assumption of monimostylic autostylism.* In all the freely streptostylic forms the great mass of the fibres of the adductor mandibulæ arose from the pterygo-quadrate and its hyomandibular suspensorium. With the reduction in the range of the streptostylism more and more of these fibres became transferred to the cranium itself. Not only was this so, but, as the hyomandibular and quadrate became successively shortened, their dermal covering bones also became approximated to the cranium, and ultimately became welded thereto. It may be further postulated that such of these bones as already carried fibres of origin of the adductor muscle would increase in size, and that any two or three contiguous bones which gave rise to fibres of the same portion of the muscle would tend to become welded together.

It appears to me that along these lines the evolution of the squamosal bone can be clearly traced, and that very definitely an intermediate stage in its evolution has been preserved to us in *Polypterus*.

A general survey gives the impression that the teleosts have perpetuated and perfected the hyostylic streptostylism of the elasmobranchs. The ganoids, definite stages in this perfecting process, show also, in varying degrees, a tendency to throw off the hereditary streptostylic influence. This revolt is least manifest in the chondrosteous ganoids, which I have elsewhere shown to be more elasmobranch than teleost in character (Kesteven[44]). It is most marked in the Crossopterygii, and appears to a very slight extent in the Holostei.

The Crossopterygii are, of course, all streptostylic and hyostylic, but the firm union of the palato-pterygoid with the cranium anteriorly, and with the parasphenoid posteriorly, the development of true maxillæ and premaxillæ, the large size of the dermal plates in front of the hyomandibular bone, and their firm union with that element on the one hand and with the dermal covering plates of the cranium on the other, are all features which appear to indicate the attempted adoption of monimostylism.

Gregory[45] suggested that the preoperculum of the fish gave rise to the squamosal. It is more probable that it was that bone in fusion with one or more of the cheek plates behind the postorbitals that gave rise to the squamosal.

Before proceeding further it may be well to note that the possession of a true squamosal along with operculum and suboperculum by *Neoceratodus*, clearly indicates that the opercular bones took no part in the formation of the squamosal.

The identification of the preoperculum in the rhipidistian skulls is somewhat confused by Gregory's treatment of the question. As already stated, he expressed the opinion that the squamosal was derived from the preoperculum, and yet he identifies that which is assuredly a cheek plate as the squamosal of *Osteolepis microlepidotus* (*loc. cit.*, fig. 2). He does the like in his study on the evolution

[41] Kesteven.—Journ. Anat., lxi, 1926, pp. 121 and 129.
[42] Gregory.—Ann. New York Acad. Sci., xxvi, 1915, p. 327.
[43] Adams.—Ann. New York Acad. Sci., xxviii, 1919, pp. 51-166.
[44] Kesteven.—Rec. Austr. Mus., xviii, 1931, pp. 167-200.
[45] Gregory.—Ann. New York Acad. Sci., xxvi, 1915, p. 337.

of the lachrymal bone in the case of *Osteolepis macrolepidotus*,[46] whilst his treatment of *Polypterus* and *Lepidosteus* and his failure to recognize the preoperculum of *Amia* as the squamosal, give the impression that either he has consistently mistaken the cheek plate for the preoperculum, or that in the later work he deemed the squamosal to have been derived from a cheek plate. Gregory (*loc. cit.*) has made the further error of identifying as the interoperculum a plate situated above and in front of the suboperculum in *Osteolepis microlepidotus*. *Amia* is in certain respects so essentially similar to the rhipidistean fishes that in those respects we may unhesitatingly use it as a standard for the identification of the affected cranial elements.

The position of the interoperculum in all these forms is determined by such a standard of identification as being behind, below, and internal to the suboperculum and behind the preoperculum. This being so, the interoperculum can hardly have been retained and evolved into the quadrato-jugal, and this will become more obvious as we proceed.

Comparison of *Amia* (Fig. 7D) with *Megalichthys* (Fig. 7A) and *Rhizedopsis* (Fig. 7B) at once enables us to determine the preoperculum in the ancient forms. The resemblance is such that it were unreasonable to doubt that it is in these forms, as in the recent ganoids, closely adherent to a hyomandibular above and to the quadrate below.

It follows, since the interoperculum lies behind and internal to the preoperculum, which in turn is bound to the quadrate, that, in the ganoids, the interoperculum is represented by one of the plates which has been designated lateral gular, or it is not present at all.

In *Osteolepis macrolepidotus* the preoperculum is apparently exposed behind the largest cheek plate which I have stippled in Fig. 7C.

In *O. microlepidotus* it is apparently quite covered by the large cheek plates; it will be remembered that in *Amia* the bone is very nearly covered by the muscle fibres that arise from it.

In the eight little drawings (Figs. 7 and 8) on pages 257 and 260 I have stippled those bones which, in fish skulls, it appears may be regarded as homologous with the squamosal, and stippled the squamosal bone itself in the last three of the series.

Consideration of the bones in question justifies the following conclusions. The squamosal bone of the Dipnoi and tetrapods is homologous with the preoperculum of the ganoids in fusion with one of the large temporal cheek plates. This bone, the squamosal, will have been bound to the quadrate in its original preopercular part, and will have been kept so bound, and, in addition, have become equally bound down to the otocrane and side wall of the cranium itself by the need of a fixed point for the muscles which arose from its lateral surface. And this is how it comes about that the primitive relation of the preoperculum to the quadrate has persisted even to the embryonic stage of the mammalian squamosal bone. The second, cheek plate, component of the primitive squamosal was extra muscular; we see the two components fused in *Polypterus*; this is the portion that reappears as a covering for the muscles of mastication in *Neoceratodus*, the stegocephalians, cotylosaurs, etc.; in short, the squamosal of the temporal roof wherever it be found.

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[46] Gregory.—Bull. Amer. Mus. Nat. Hist., xlii, 1920, fig. 1.

Returning again to Watson's description of the quadrate and squamosal bones in *Loxomma* already quoted, I have carefully made wax models from his drawings and find that, if his description and illustrations be correct, then in this form the squamosal bone is placed between the quadrate and the cranium, and is the

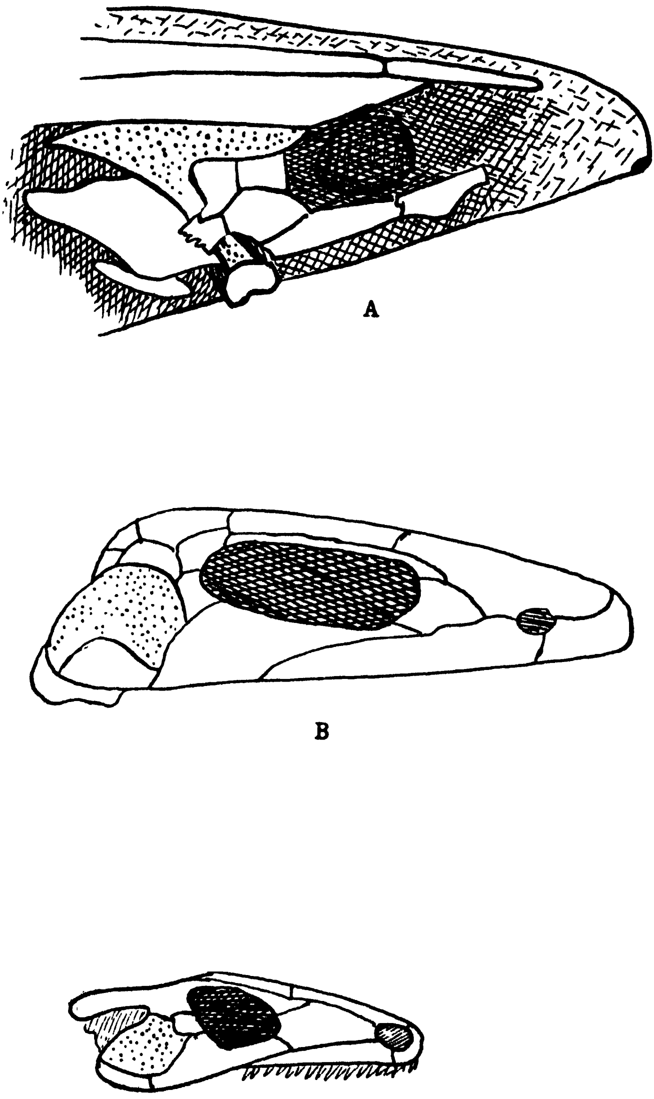

Fig. 8.—A, *Neoceratodus*; B, *Loxomma* (a reconstruction based on the figures of Embleton and Atthey); C, *Seymouria* (from Gregory). The squamosal bone has been stippled in the three drawings.

only means whereby the former is attached to the latter. Such a condition is quite without parallel, and, moreover, it imposes a tremendous disability upon, and an extraordinary origin and direction for, the adductor mandibulæ muscles. The disability is that they are constrained to pull forward and up, so that they pull against the capsule of the articulation. The extraordinary origin is that they arise from the *under* surfaces of the quadrate and squamosal bones; the dorsal and lateral surfaces of the quadrate are, according to his description, entirely covered by the subdermal squamosal and quadrato-jugal bones.

Whilst Gregory was in error in his identification of the interoperculum in the rhipidistian fishes, it is probable that he was correct in his indication of the bone from which the quadrato-jugal of the tetrapods has been evolved. If the crossopterygian fishes present us with the homologue of the bone at all, it must have been the lower of the two cheek plates, as he indicates.

Reviewing, now, the structure of the skull of the Dipnoi, the comparisons that have been made, and the homologies that have been established, it becomes apparent that they support an opinion previously expressed. The Dipnoi are primitive amphibians (Kesteven[47]).

They are also modified fish, but they have, as it were, progressed so far along the evolutionary road that led to the Amphibia that they are nearer the end of that road than they are to its beginning.

If the last two paragraphs be statements of fact, then the Dipnoi must approach more nearly to the structure of the common ancestor of all the amphibians than does any other known form; later it may be found that there is preserved to us among the known fossils a survivor from the same group as the common ancestor.

4. The Crossopterygian ancestry of the Tetrapoda.

It is believed by other workers that the tetrapoda were derived from the crossopterygian fishes. It is proposed to examine the evidence on which this theory rests, in so far as that is derived from cranial structures.

Gregory[48] appears to have offered the most extended defence of the thesis. On page 337 of his work he itemizes nine changes whereby the "primitive stegocephalian skull has been derived from the rhipidistian."

A critical reading of his nine "advances" reveals the fact that they are for the most part concise descriptions of the observable differences, and where they are not so, then they are but recapitulations of his conclusions on the homology of the various bones. Whilst we can agree with him in his decisions as to most of the homologies, it has to be pointed out that this is not evidence that the amphibian skull has been derived from the crossopterygian, but rather that both have inherited these similar elements in modified form from a common ancestor. One may point to the occipital bones of the mammals as being completely homologous with those of the birds, but this is not evidence that the former is derived from the latter.

Watson[49] has compared the bones on the base of the skull of *Megalichthys* with those of *Loxomma*, and his remarks are largely reprinted by Gregory in the paper

[47] Kesteven.—Rec. Austr. Mus., xviii, 1931, pp. 167-200.
[48] Gregory.—Ann. New York Acad. Sci., xxvi, 1915, pp. 317-383.
[49] Watson.—Mem. Proc. Manch. Lit. Phil. Soc., lvii, 1, 1912.

above quoted. It is apparent that in some respects Watson has misinterpreted the palate of *Loxomma*, and that the comparisons with *Megalichthys* are loosely made.

The "curious type of tooth change" which is said to be "very characteristic of the Stegocephalia, and unknown elsewhere except in the Crossopterygian fish" and which he deems to be "a strong additional reason for regarding the Tetrapoda as derived from this group of fish," is by no means confined to the crossopterygian fishes. It is present in both agamid and varanid lizards and in the Boidæ among the ophidians. Among fish not crossopterygian this form of tooth change is found not only in *Lepidosteus*, as Watson states, but also in *Amia*, and is so frequent of occurrence among the Teleostei that one is almost tempted to describe it as the common tooth change among the bony fishes. Teeth are epidermal structures, and the form of replacement under discussion reproduces fairly faithfully, but on a bony basis, the mode of replacement which characterizes the whole of the Elasmobranchii. In short, this is a primitive mode of tooth replacement, and is due to the fact that the tooth buds have not been split off from the deeper layer of the dermis and submerged or grown down among the subcutaneous tissues.

On the other hand, the more advanced mode of development within a bony socket may not be relied upon very much as indicating any more than an advanced method of tooth replacement, for I find in my collection of teleostean heads that quite closely allied forms may exhibit the two modes of replacement.

Following a well-founded statement that the evidence points to the separation of the reptilian stock early in the history of the Stegocephalia, Watson proceeds: ". . . comparison [of *Loxomma* and *Pteroplax* skull] with *Megalichthys* shows an equally marked resemblance to the Crossopterygian fish."

"The basisphenoid of *Megalichthys* has sometimes carotid foramina just as in *Loxomma*." This, too, is merely a primitive feature, and, moreover, one which has been shown to have persisted in almost every one of the Gnathostomata, with the exception of those bony fishes which have a well developed myodome. Whether the canal actually perforates the fused basisphenoid and parasphenoid on the base of the cranium, as in *Loxomma* and *Megallichthys*, or whether it finds its way through at the outer edge of the latter bone where that sutures with the prootic, depends upon the width of the parasphenoid, and is entirely without significance. In some siluroids and apodes the canal perforates the fused bones, in others it passes in at the suture.

In the Elasmobranchii the canal perforates the cartilaginous basis cranii in a precisely similar position. *Doubtless the constancy of the Gnathostomata in this respect is traceable to the elasmobranch ancestor, and results from the mode of origin of the eye and the relation of its stem, the optic nerve, to the vascular hypophysis cerebri. The prime importance of these organs may well be supposed to have maintained a static condition in their vascularization.*

It is more than probable that the "basipterygoid process" of *Megalichthys* is parasphenoidal and not basisphenoidal as it is in the Embolomeri. That the . . . "long parasphenoid [of *Megalichthys*] extends forward to the premaxillæ as it *may* do in *Pteroplax*," is only a possible point of resemblance.

"The pre-vomer [of *Megalichthys*] is identical with that of Loxomma in the majority of its attachments . . . It meets its fellow of the opposite side, and *forms the front of the posterior naris* . . ." On the palate of a ganoid!

This passage was quoted by Gregory[50] as, indeed, were my other quotations from Watson here anent, and it is surprising that so keen a student of comparative craniology should have failed to observe the paradox.

If *Megalichthys* has the posterior naris bounded in front by pre-vomers at all, then that posterior naris must be in the roof of the mouth, and *Megalichthys* differs fundamentally from every other teleostome.

The palato-pterygoid of *Megalichthys* may resemble the palatine and pterygoid of *Pteroplax*, but such resemblance must be purely superficial. Any one of the Mormyridæ would present an even closer resemblance in the relation of the bones, for in these teleostean fishes the medial borders of all the median bones developed on the palato-pterygoid arch are actually fused to the lateral margin of the parasphenoid; but here, as in *Megalichthys*, all those bones are genetically related to the cartilaginous arch, so that their relation to the basis cranii is secondary and fundamentally different to that of the palatine and pterygoid of *Pteroplax*.

In conclusion, it may be stated that such resemblances as are demonstrable between the Crossopterygii and the Stegocephali are of two kinds; firstly, parallelisms, which are devoid of phylogenetic significance, and secondly, true homologies. All these latter are more satisfactorily accounted for by the assumption that both groups have derived them from a common ancestor than by the assumption that the tetrapods are derived directly from the Crossopterygii. The geological record of the antiquity of the two groups supports this view.

The conclusions I arrived at in a recent paper on the evolution of the Anamniota, and the genealogical diagram I then published, are supported by the present communication.

LIST OF ABBREVIATIONS USED ON THE FIGURES.

A.c.a.—External aperture of canal for the anterior carotid artery.
A.o.b.—Antorbital buttress.
A p.—Ascending process of the quadrate.
B.p.—Basal process of the quadrate.
Can. art. c.—Canal for the cerebral artery.
F. pr. ot. e.—Foramen prooticum externum.
Fr.—Frontal.
J.—Jugal.
La.—Lachrymal.
Pa.—Parietal.
Pb. can.—Parabasal canal.
Pb. can. a.—Anterior aperture of the parabasal canal.
Po.f.—Postfrontal.
Po.o.—Postorbital.
Pr.f.—Prefrontal.
Q.j.—Quadrato-jugal.
Sq.—Squamosal.
II.—External aperture of optic nerve canal.
III, IV, V, VI.—Common aperture of canals for third, fourth, (?) and first branch of fifth, and sixth nerves.
VII.—External aperture of canal for the hyomandibular branch of seventh nerve.
IX and X.—External apertures of the canals for the ninth and tenth nerves.

[50] Gregory.—Ann. New York Acad. Sci., xxvi, 1915, p. 332.

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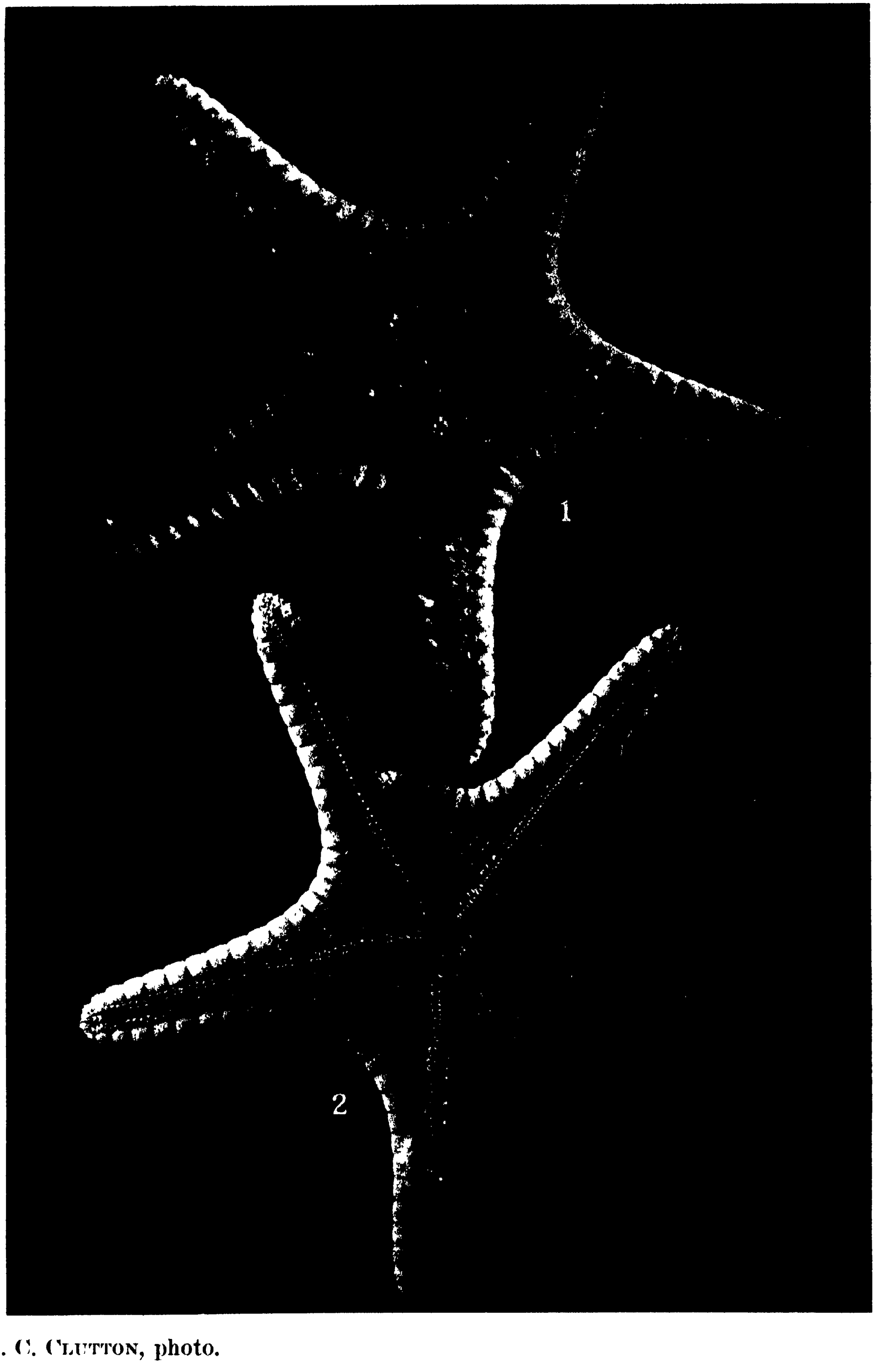

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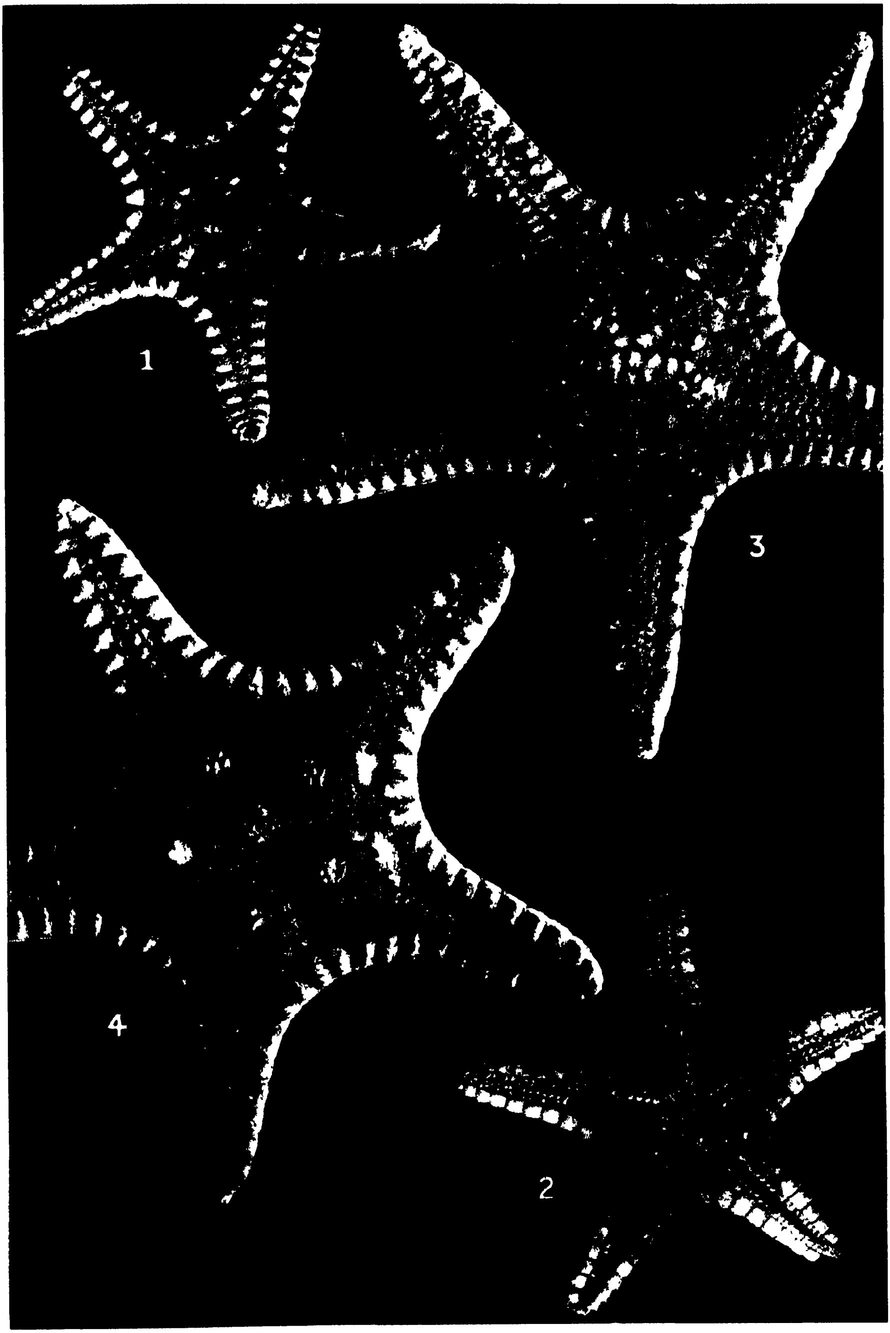

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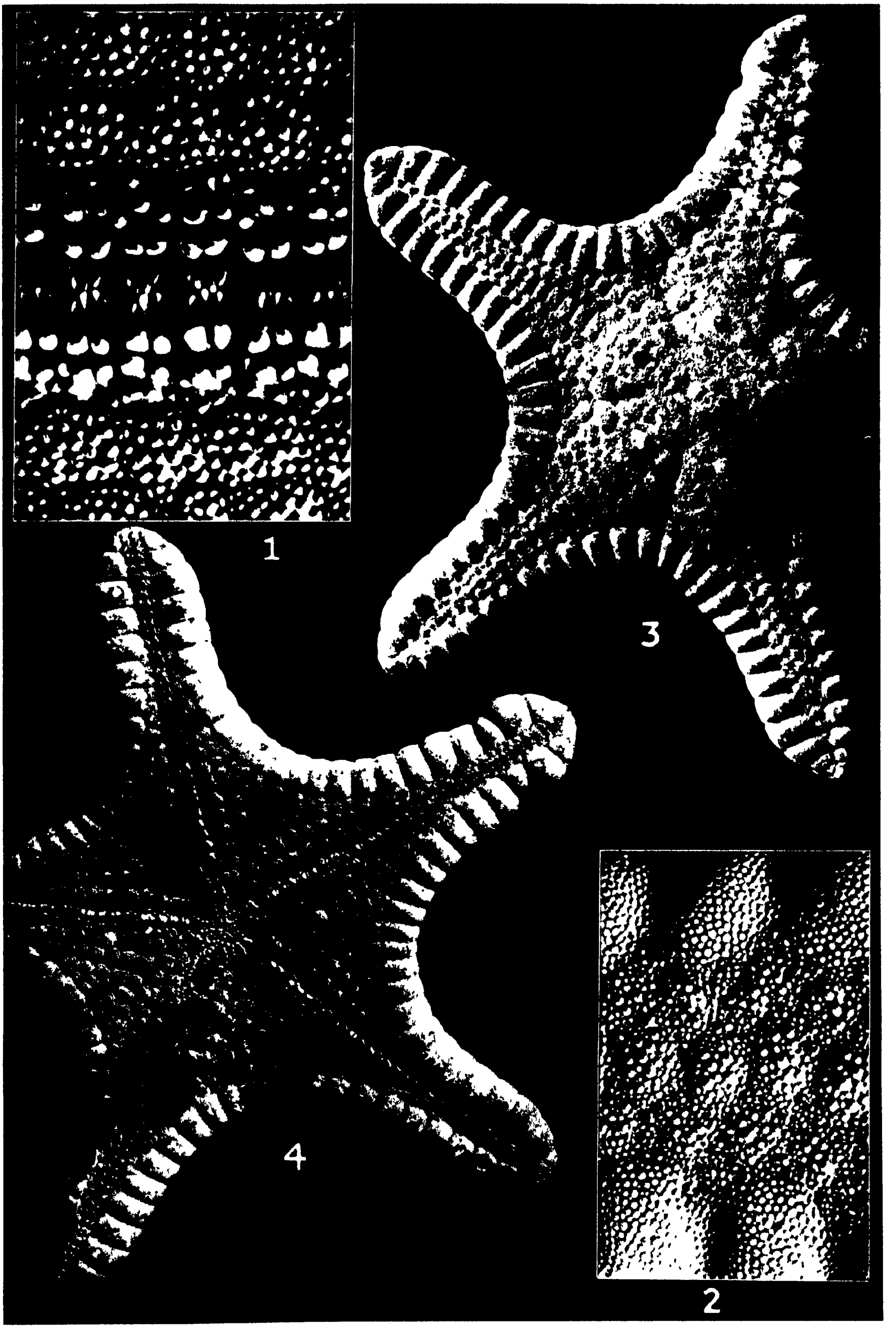

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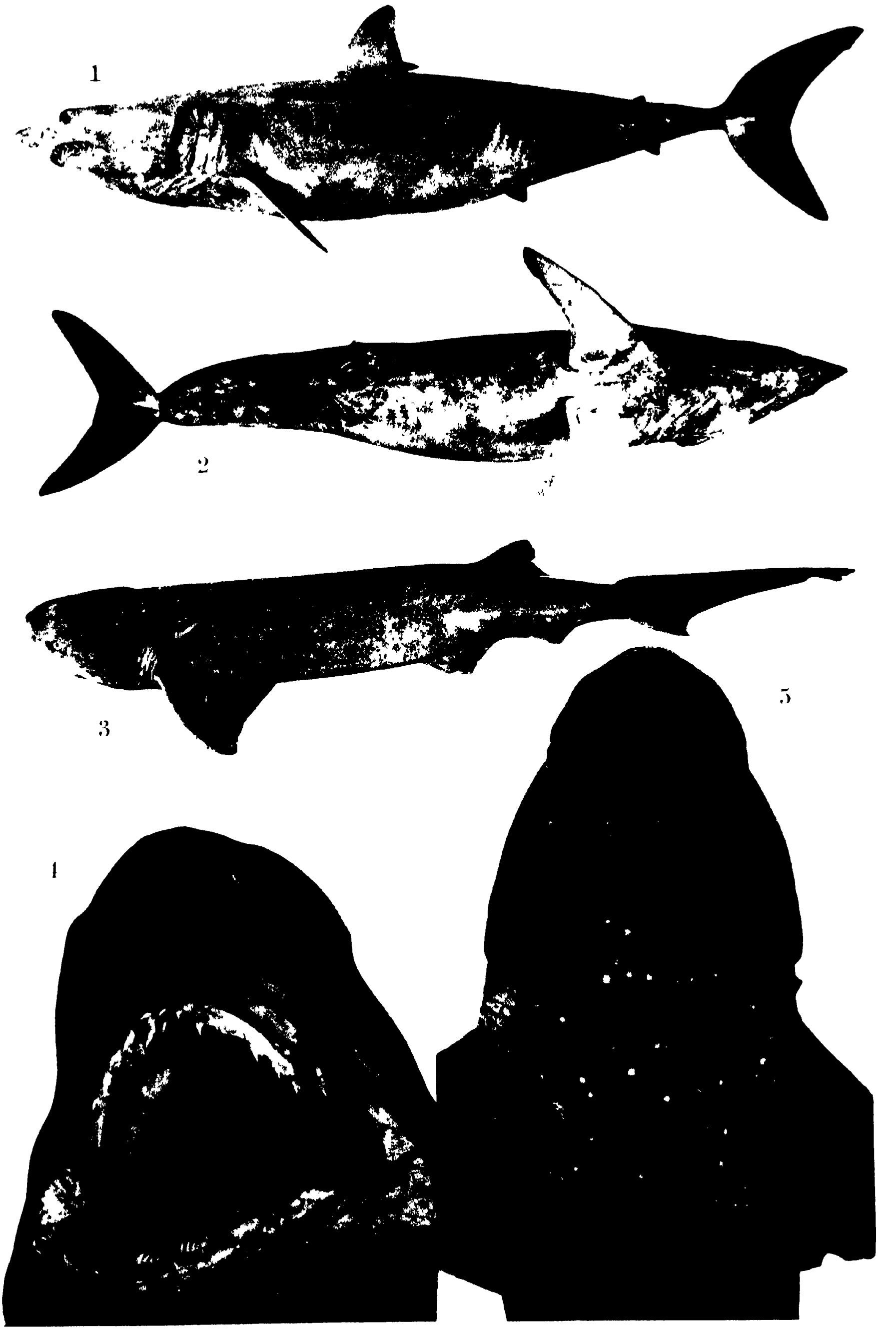

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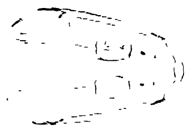

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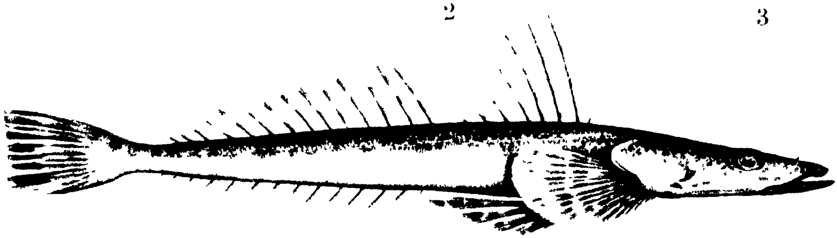

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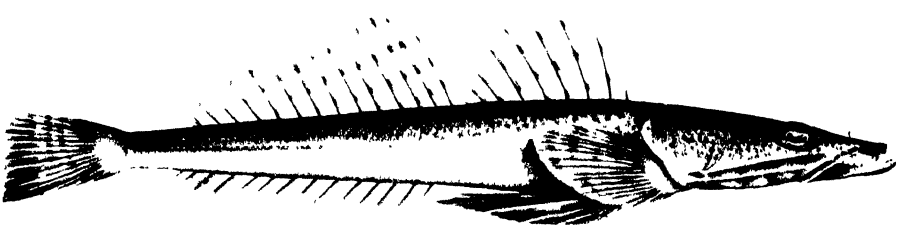

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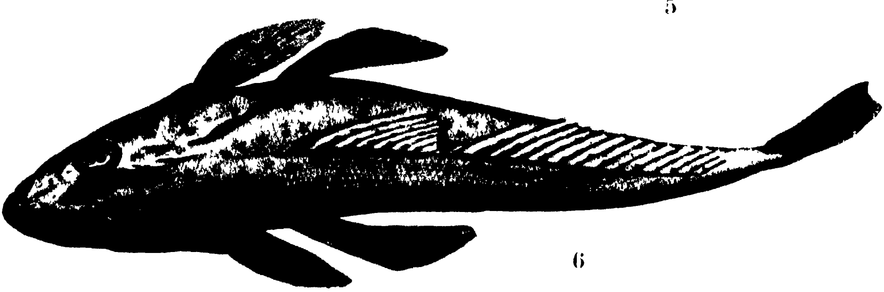

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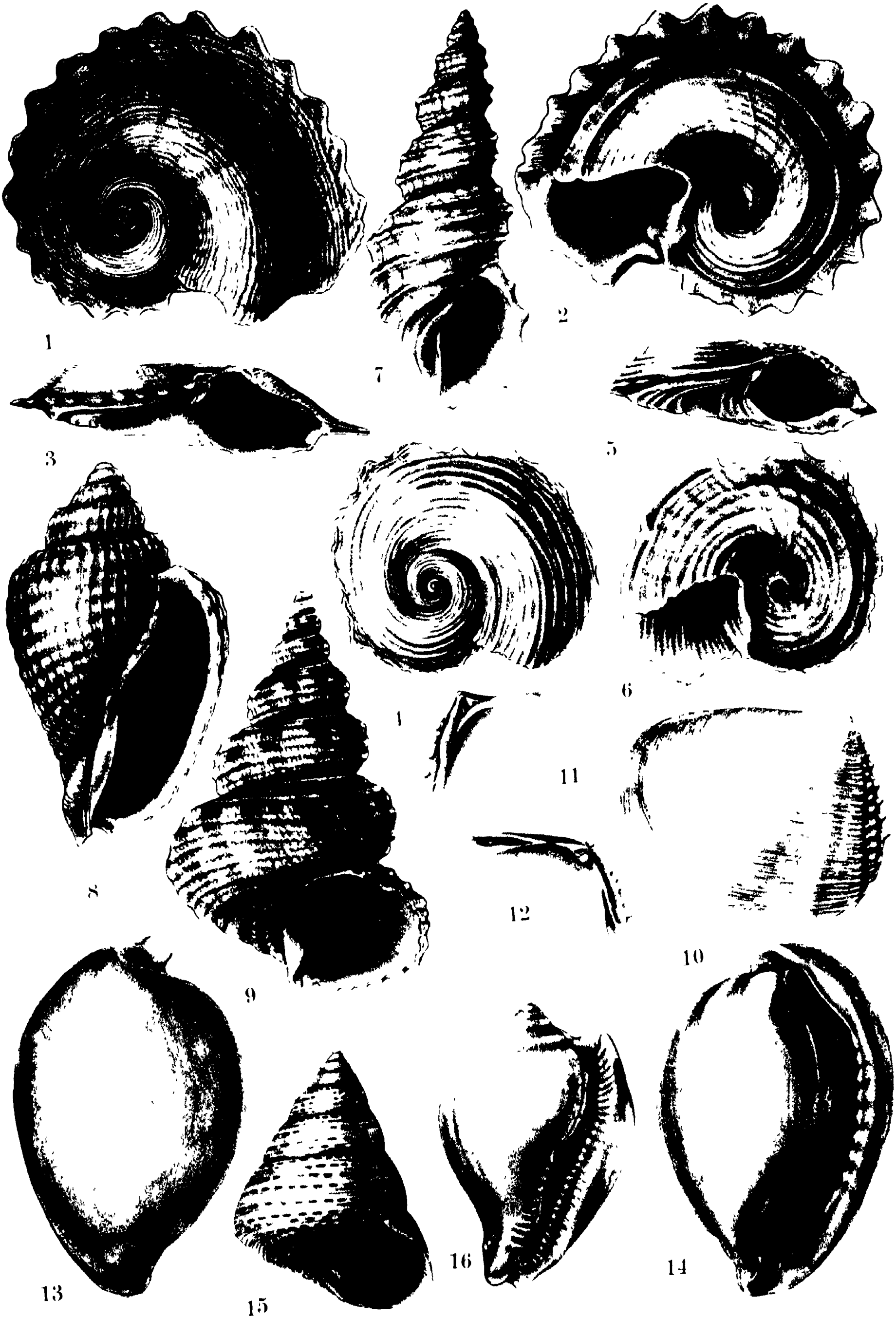

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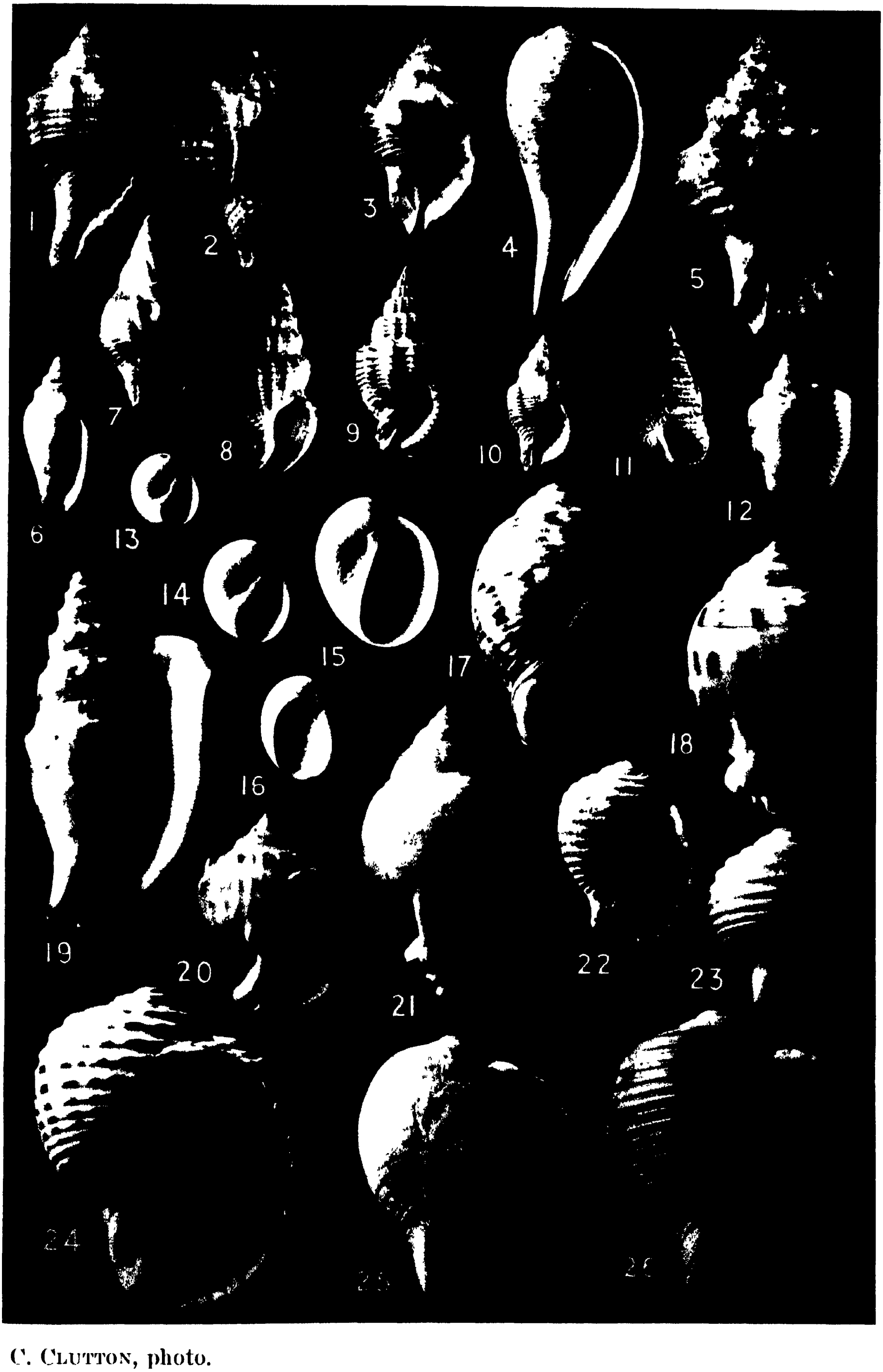

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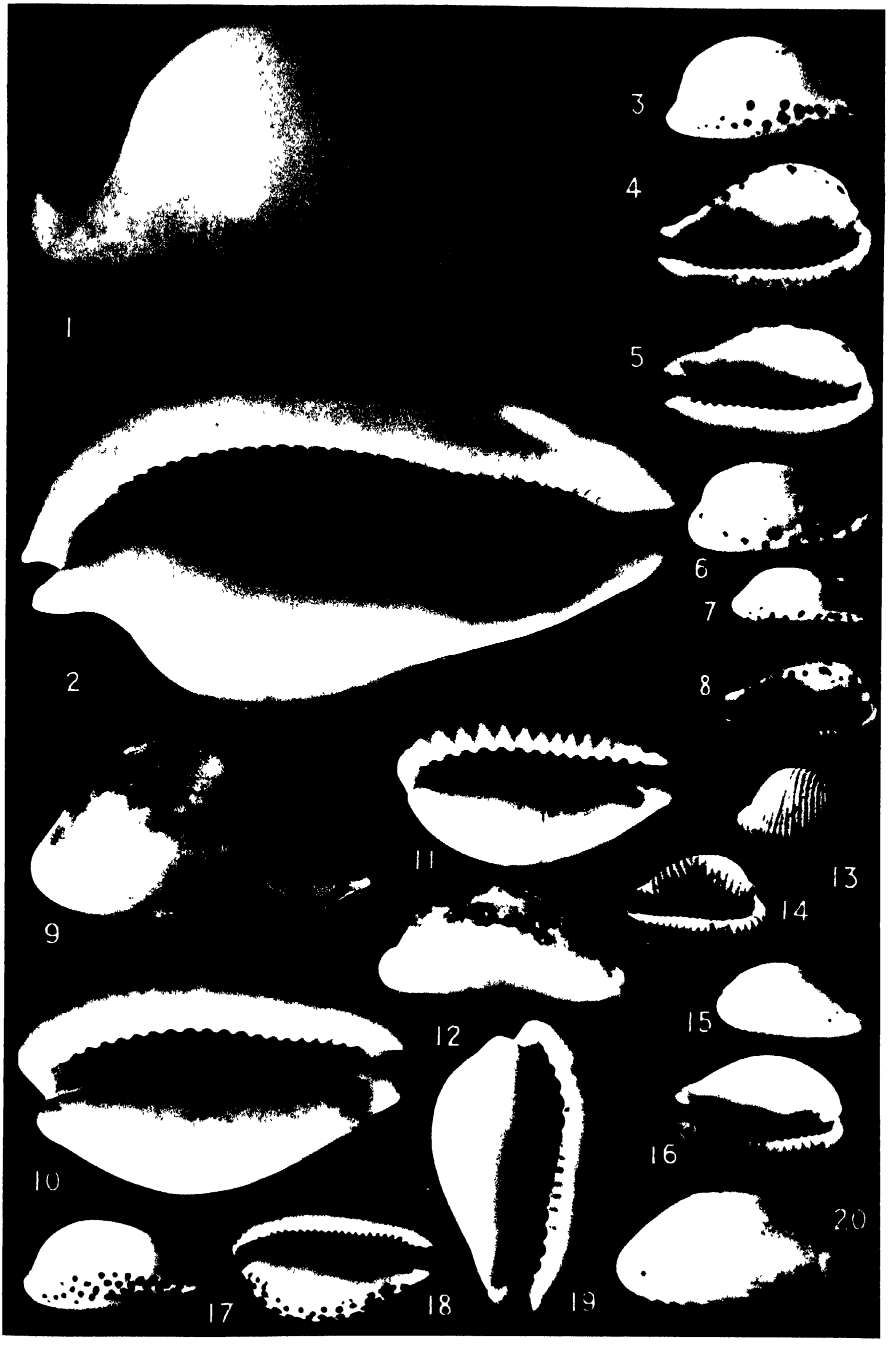

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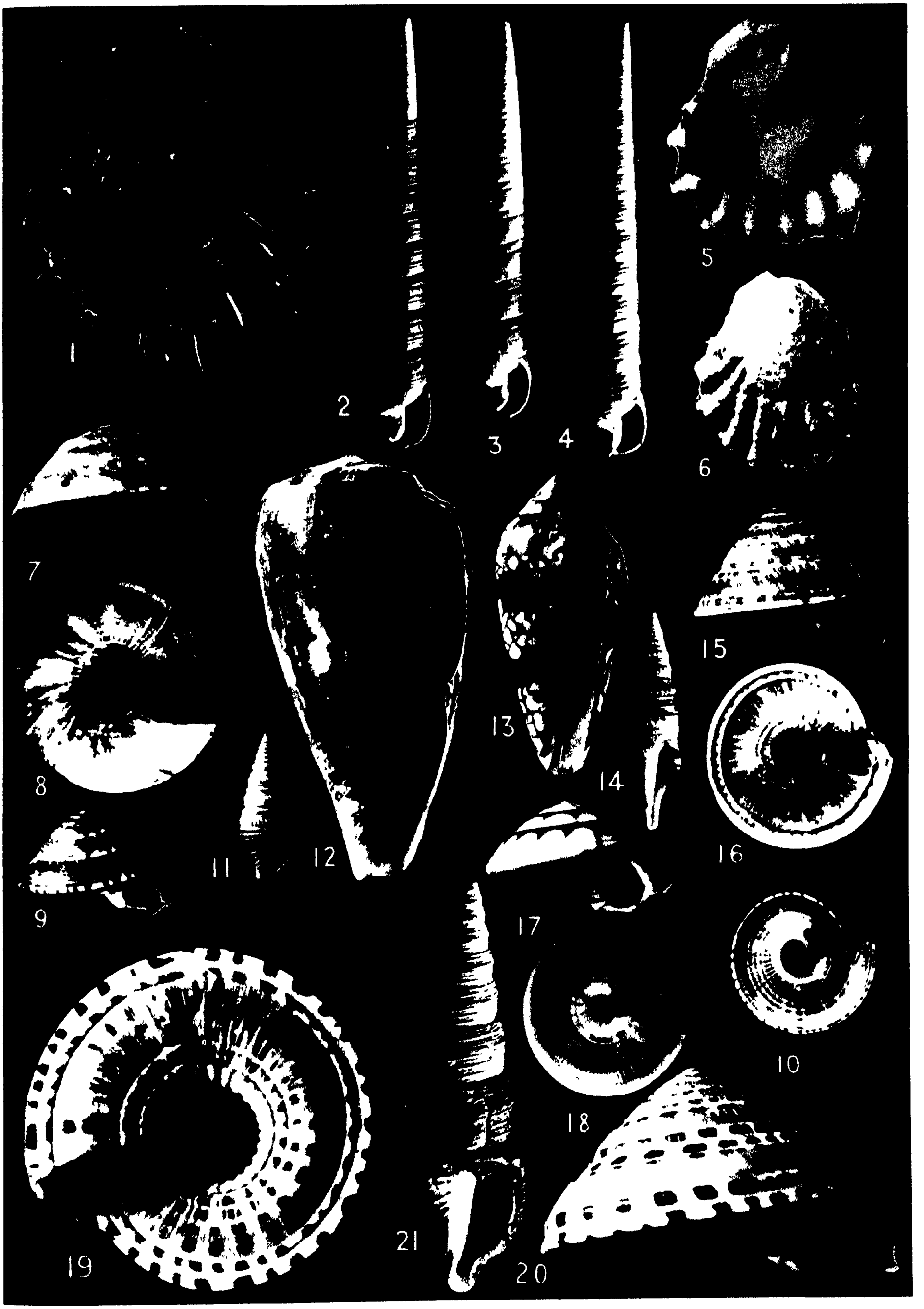

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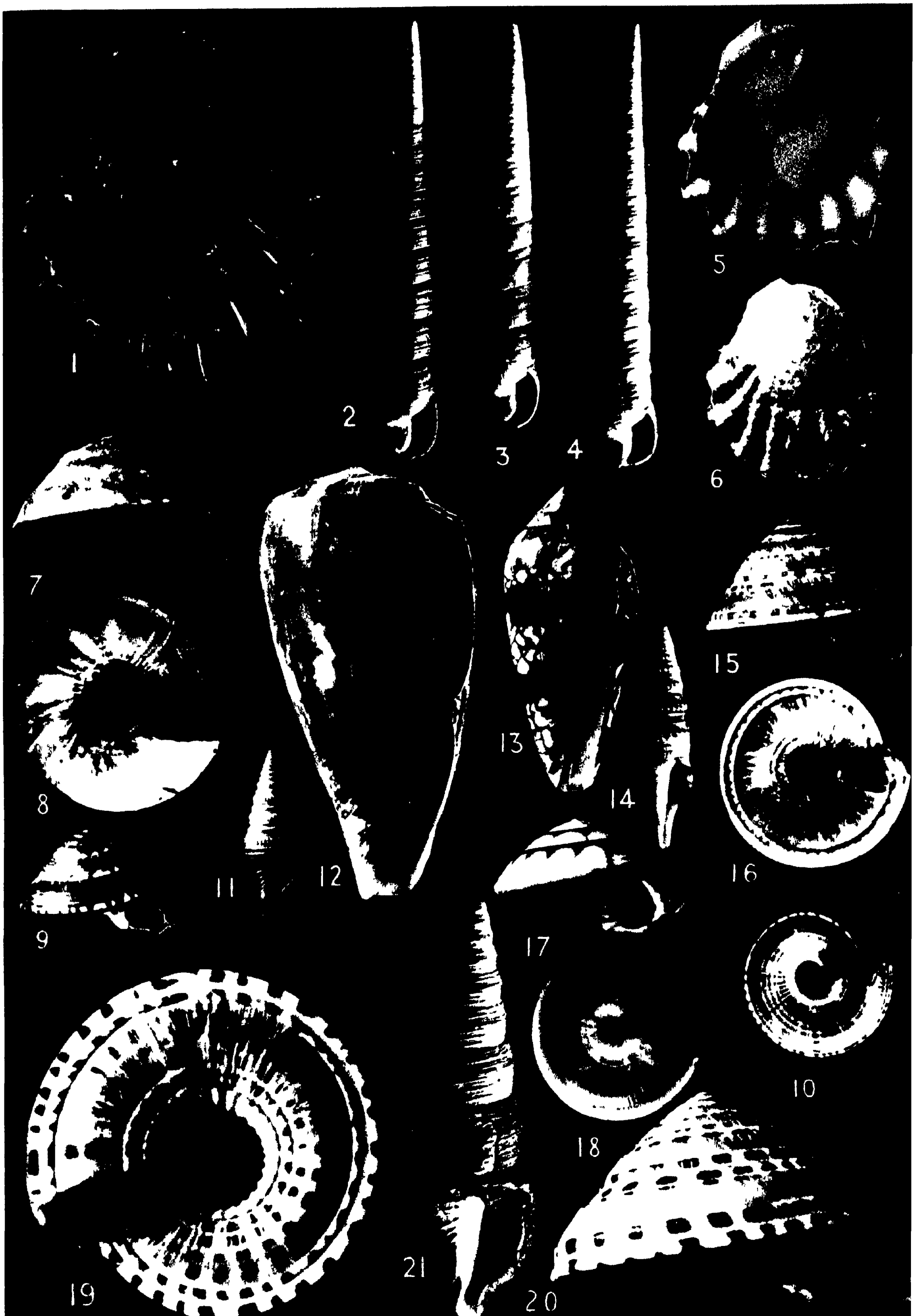

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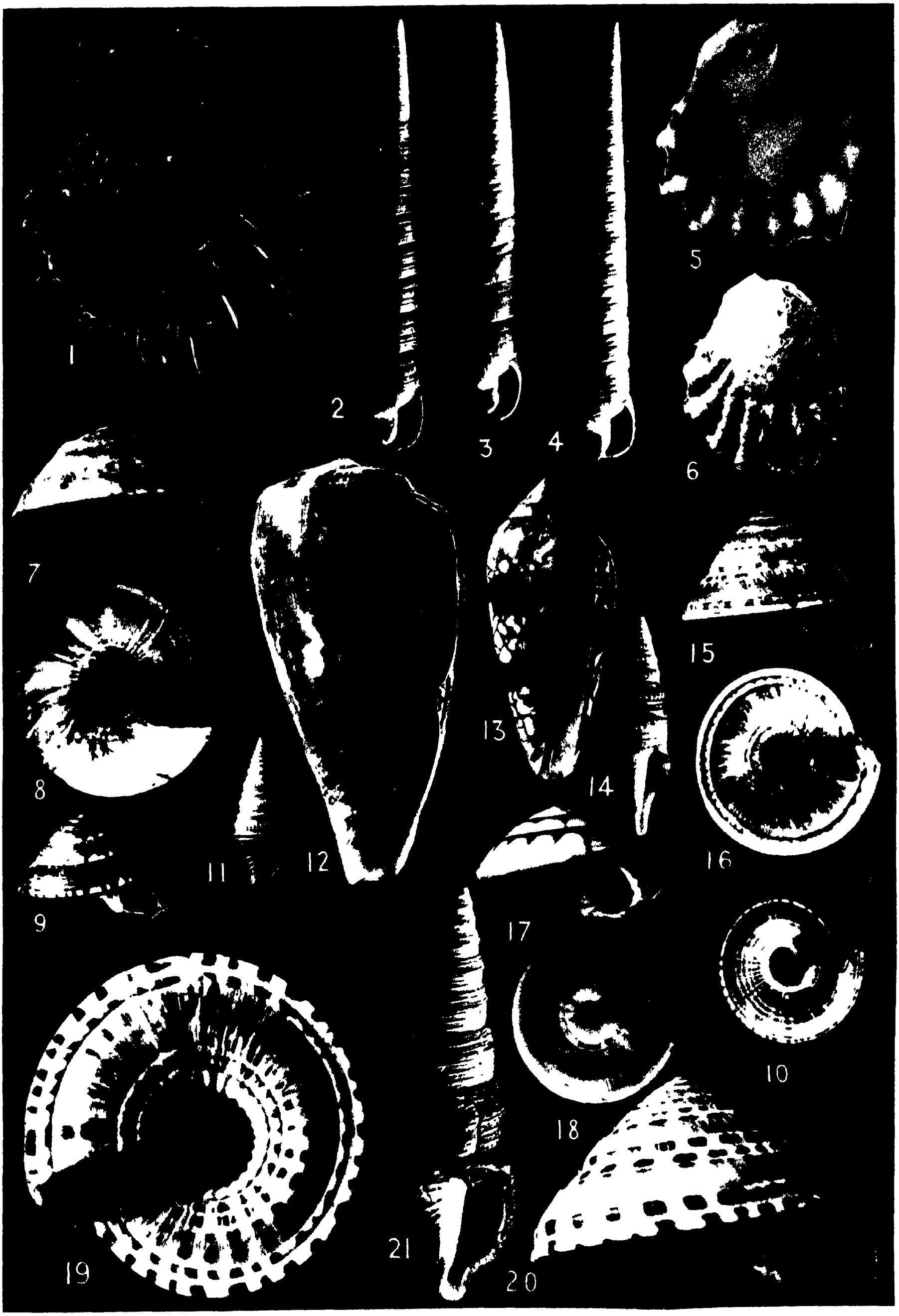

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HERPETOLOGICAL NOTES.

No. 3.*

By

J. R. Kinghorn, C.M.Z.S.,

Zoologist, The Australian Museum.

(Figures 1-2.)

The following paper contains the description of a new species of snake from the Roper River, North Australia, and a new gecko from Boggabri on the northern tablelands of New South Wales.

Rhynchoelaps roperi, sp. nov.

Snout prominent, shovel-shaped, obtusely pointed from above, lateral edges very sharp. Rostral broader than deep, its upper portion forming an acute angle posteriorly and wedged between the internasals; it is longer than its distance from the frontal. Internasals and prefrontals obliquely disposed and broader than deep, the internasals being smaller than the prefrontals. Frontal about as broad as deep, much shorter than its distance from the end of the snout, not as

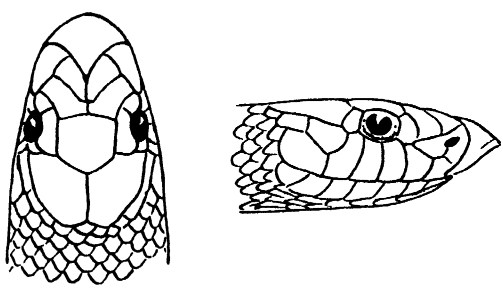

Figure 1.—*Rhynchoelaps smithii*, sp. nov.

long as the parietal, but longer than the parietal suture and at least three times as wide as the supraoculars. Nasal shield deeply grooved below the nostril, almost semidivided. There are six upper labials on the right side of the mouth and five on the left, where there is also a small one between the upper portion of the third and fourth. The third, fourth, and fifth labials enter the orbital ring. There are seven lower labials, and two anterior and three posterior chin shields, the anterior being larger than the posterior. There is one preocular and one postocular shield. Temporals 1 + 1. Ventrals 162; subcaudals 19 pairs; scales in 15 rows; anal single. Total length 295 mm., tail 25 mm.

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* For No. 2 see Records of the Australian Museum, xviii, No. 3, 1931, pp. 85-91.

Colour (in spirits).—Straw-coloured above, with a dark brown blotch on the head and thirty-nine brown bars across the body and tail. The under parts are whitish.

Locality.—Roper River, North Australia. Described from a single specimen collected during May, 1929, by Mr. K. Langford Smith.

Holotype in the Australian Museum, Reg. No. R.9930.

Affinities.—*R. roperi* has fifteen rows of scales, as have *R. bertholdi* and *R. fuscicollis*, but it differs from the former mainly by having a shovel-shaped instead of a rounded snout, and from the latter by having only one anal and temporals 1 + 1, *R. fuscicollis* having two anals and temporals 2 + 2.

Superficially *R. roperi* resembles *R. campbelli*, a species which I recently described[1] as new, from Almaden, Queensland, but the latter has seventeen rows of scales, two anals, and the rostral shorter than its distance from the frontal.

The Western Australian species, *R. semifasciatus*, also resembles *R. roperi* in the shape and general disposition of the head shields, but it has seventeen rows of scales and two anals.

A tabulation of the main characters is given below for comparison.

	Scales.	Anals.	Temporals.	Subcaudals.	Ventrals.	Snout
R. bertholdi ..	15	2	1 + 1	15-25	126	Rounded
R. fuscicollis ..	15	2	2 + 2	20	143	Shovel-shaped.
R. roperi	15	1	1 + 1	19	162	
R. campbelli ..	17	2	1 + 1	18	153	
R. fasciolatus ..	17	2	1 + 1	22-27	145-161	
R. australis ..	17	2	1 + 1	18-20	152-163	
R. semifasciatus	17	2	1 + 1	17-25	143-170	

Heteronota walshi, sp. nov.

Head oviform, depressed, more than half as long as its distance from the vent. Snout longer than the diameter of the orbit. Orbit as long as its distance from the nostril and equal to its distance from the ear. Ear vertical elliptic, small, and not as large as the pupil of the eye, which may be round or a vertical slit. Body about as high as broad at the centre, covered above with small granules intermixed with subtriangular but bluntly keeled tubercles, which are scattered irregularly over the back and sides. The under surface is covered with small, cycloid, subimbricate scales or granules, which are smallest on the gular region, becoming larger towards the vent. The snout is covered with granules similar to those on the dorsal surface of the body. The rostral is much broader than deep, the loreal region well defined. The nostril is bordered by two or three large scales in front and above, with small ones posteriorly, and it is separated from the rostral by the large anterior scale. Six or seven rows of small granules on the snout separate the nostrils. There are thirteen to fourteen upper labials and thirteen lower labials. There are no chin shields, and the mental is large, trapezoid, and narrower than in *H. bynoei*.

Digits not dilated, rounded, rather slender, covered with imbricate, cycloid scales above and a row of plates inferiorly. Claws retractile, situated between

[1] Kinghorn.—Rec. Austr. Mus., xvii, 4, 1929, p. 191.

two plates, the lower being deeply notched. There are seventeen to eighteen lamellæ under the fourth toe. Tail nodular, about as large as the head and covered with flat scales.

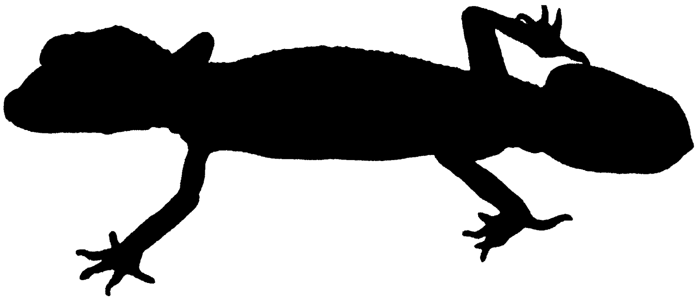

Figure 2.—*Heteronota walshi*, sp. nov.

Colour (from life).—Light brown above, with a few dark brown lines on the snout, sides, and hinder portion of the head and neck. The limbs and body are speckled with dark brown, which, on the mid-dorsal surface, form more or less well defined rings, with a small white tubercle in the middle of each.

Locality.—One specimen (the holotype) from Boggabri, on the northern tablelands of New South Wales, and two specimens without locality, but which I have reason to believe came from the north-west of this State.

Holotype in the Australian Museum, Reg. No. R.10266. Paratypes No. R.6772–3. The following are the measurements in millimetres:

	Holotype R.10266.	R.6772.	R.6773.
Width of head	16	16·5	15
Length of head	23	23	22
Snout to vent	73	65	64
Tail	19 × 19 × 10	21 × 14 × 9	20 × 15 × 10
Fore limb	28	25·5	24
Hind limb	36	35	34

The tail measurements are taken in the following order: length, width, and depth.

STUDIES IN AUSTRALIAN ATHECATE HYDROIDS.

No. IV. Development of the Gonophores and Formation of the Egg in *Myriothela harrisoni*, Briggs.*

By

E. A. BRIGGS, D.Sc.,

Lecturer in Zoology, University of Sydney.

(Figures 1-3.)

INTRODUCTION.

The following account of the development of the gonophores and the formation of the egg in *Myriothela harrisoni* is based on a single female and several male specimens collected on the undersides of rocks below low-water mark at Bulli, forty miles south of Sydney. Although *M. harrisoni* is a diœcious form, it bears a distinct resemblance in its gross morphology to *M. cocksi*, which occurs under similar conditions on the coasts of Great Britain and western Europe. Both species have a chitinous investment by perisarc covering the hydrorhiza and forming a firm basis of attachment to the surface of the sub-stratum. This likeness is further emphasized by a study of the development of the gonophores and the formation of the egg, which follows through a series of stages very similar in their general details to those I have already described for *M. australis*.

Unfortunately, corresponding stages in *M. austro-georgiæ* are not available for comparison, since Jäderholm figures only a fairly advanced male and female gonophore. In his drawings on plate iii, figure 1 shows a female gonophore before the fusion of the plasmodial areas to form the definitive ovum, while figure 2 depicts a male gonophore in which the sub-umbrellar cavity appears to be filled with densely-packed secondary spermatocytes. Although Thomson's figures[1] illustrating his "Note on the Gonostyles of two Antarctic Siphonophora" refer to *M. austro-georgiæ*, they are too diagrammatic and lacking in detail to be of any value for comparative work.

The paper concludes with a brief discussion on the geographical distribution of the members of the genus *Myriothela*. Previous to the discovery of *M. australis* and *M. harrisoni*, the representatives of the genus had hitherto been recorded only from the circumpolar seas of the Northern and Southern Hemispheres, but the range of *Myriothela* must now be extended to include the warm coastal waters of eastern Australia in the neighbourhood of Lat. 34° South.

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* For Numbers I, II and III see RECORDS OF THE AUSTRALIAN MUSEUM, Vol. xvi, No. 7, 1928, p. 305; Vol. xvii, No. 5, 1929, p. 244; Vol. xviii, No. 1, 1930, p. 5.

[1] Thomson.—Proc. Roy. Phys. Soc. Edinb., xvi, 1904-1906, pp. 19-22.

DEVELOPMENT OF THE GONOPHORES IN MYRIOTHELA HARRISONI.

The fully-developed blastostyle consists of an irregularly lobed base with a narrow, cylindrical, distal portion continued into a single terminal tentacle, generally resembling those of the tentacle-bearing region of the hydranth, but flatter distally and of larger size. The blastostyle has no mouth, but contains an extensive gastric cavity communicating with the general body-cavity of the hydranth.

In *M. harrisoni* all the gonophores on a blastostyle are of the same sex, and throughout any one individual the sex of the gonophores is uniform. The mature gonophores are sub-spherical in shape, somewhat flattened distally, and are either sessile or very shortly pedunculate. They exhibit no definite arrangement on the blastostyle, except that the mature ones are borne distally and appear terminal in position, having grown so large as to push the single tentacle to one side.

The lobes at the base of the blastostyle represent developing gonophores.

In the male, the blastostyle bears two or three ripe gonophores, up to 450 μ in diameter, and three or four in process of development. The only female individual was cut into sections before the diœcious habit was discovered and entire blastostyles are not available for comparison. A reconstruction from the sections shows a mature female gonophore occupying a terminal position at the distal extremity of the blastostyle. On the proximal side of this is a smaller gonophore whose sub-umbrellar cavity is filled with closely-packed oogonia and a few primary oocytes. A second blastostyle carries two young gonophores in which the oogonia are clearly discernible. The ripe female gonophore has a diameter almost twice that of the male. Both male and female gonophores have an apical opening representing a velar aperture similar in appearance and structure to the opening which I have already described in the gonophores of *M. australis*.

Development of the Male Gonophores.

The first stage in the formation of the male gonophore is due directly to the evagination of the endoderm cells of the blastostyle. This penetrates deeply into the ectoderm, and the interstitial cell at the apex of the evagination divides to form a rounded mass of cells which becomes cut off from the rest of the endoderm by the formation of a thin though definite, non-cellular layer. The ectoderm surrounding this mass of cells remains stratified and heavily charged with nematocysts except over the outer surface of the evagination where the ectoderm is reduced to a single layer of epithelial cells (Fig. 1). The pressure exerted by this penetration causes the ectoderm to bulge outwards so that even at this early stage in the development of the gonophore the ectoderm appears slightly raised above the general surface of the blastostyle.

The *Glockenkern*, thus established, increases in size and a split occurs in the cell-mass where a small eccentrically-placed cavity is formed. As this enlarges, the cells in the roof of the cavity become arranged in a single layer, while those on the floor form a cushion in which the cells are arranged in several layers. This cavity or chamber is at first spherical in shape and constitutes the *Anlage* of the sub-umbrellar cavity. Very soon, however, it becomes flattened and appears semicircular in section with its floor composed of a mass of cells which quickly become differentiated from those occupying the two lateral wings.

At this stage, owing to the rapid growth of the gonophore, the ectoderm is forced outwards and forms a distinct projection on the surface of the blastostyle.

The gonophore, thus coming to project completely on the exterior, is covered by ectoderm which is reduced to a single layer of columnar cells over its summit and sides, but which remains as a stratified layer rich in nematocysts around its base.

The gastric endoderm now begins to proliferate rapidly, forming numerous villi that project into the gastric cavity and reduce considerably the extent of its lumen. As this cavity continues to enlarge the endoderm cells become heavily

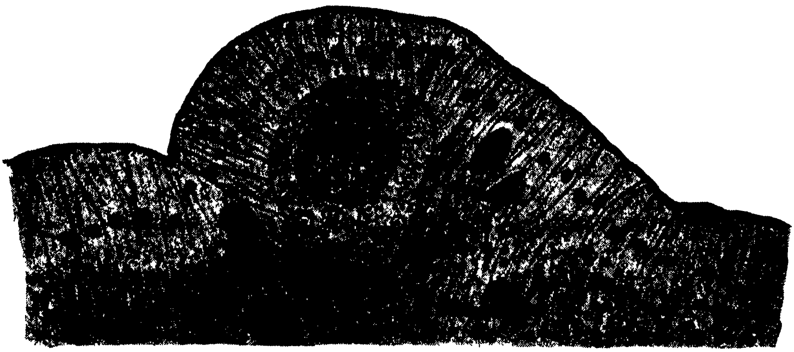

Figure 1.
Myriothela harrisoni, Briggs. Very young male gonophore.

charged with nutritive spheres which form a very important nutritive material for the development of the gonophore. The outgrowth of the gastric endoderm gives rise to the manubrium. This forces back the cells on the floor of the sub-umbrellar cavity, thus reducing the cavity to a narrow cleft of crescentic form with its horns prolonged laterally over the sides of the manubrium.

Owing to the internal pressure produced by the outgrowth of the spadix, the endoderm-lamellæ occupying the roof of the sub-umbrellar cavity commence to separate in the axis of the gonophore. At this point the endoderm-lamellæ eventually become widely separated leaving a distinct gap across which stretches a very narrow band of mesoglœa. In *M. cocksi*, Benoit has described a similar separation of the endoderm-lamellæ, but the gap forms a funnel which becomes filled with a mass of non-cellular substance. In *M. harrisoni*, at this stage, the gap remains open for a time while the endoderm cells surrounding it proliferate and arrange themselves in two layers. It is at this point in *M. cocksi* that the cells of the endoderm-lamellæ become excavated to form the circular canal, but in *M. harrisoni*, as well as in *M. australis*, the cells remain solid, forming a compact mass, and the circular canal fails to develop.

At the same time the cells occupying the two lateral wings of the sub-umbrellar cavity form an epithelium which becomes closely applied to the endoderm-lamellæ except in the axis of the gonophore. Here the cells of the sub-umbrellar epithelium enter the gap between the endoderm-lamellæ and come into close contact with the columnar cells of the ectoderm. Throughout the whole of its extent the sub-umbrellar epithelium is separated from the other cell layers by a very thin layer of supporting lamella.

The outgrowth of the manubrium also affects the cells on the floor of the sub-umbrellar cavity, causing them to form a crescent-shaped mass over the surface

of the spadix. From the cells of this layer are derived the male reproductive elements. An examination of the gonophore at this stage discloses that it has assumed a sub-spherical form, 180 μ in diameter, and developed a very short peduncle by which it retains its connection with the blastostyle. At the distal pole of the gonophore the ectoderm has become raised into a small circular patch composed of deep columnar cells lying directly above the gap between the endoderm-lamellæ. The ectoderm at the flattened distal extremity of the gonophore is armed with scattered nematocysts of the cylindrical variety corresponding to Benoit's "nématocystes fonctionnels," which in *M. cocksi* disappear before this stage in the development is reached.

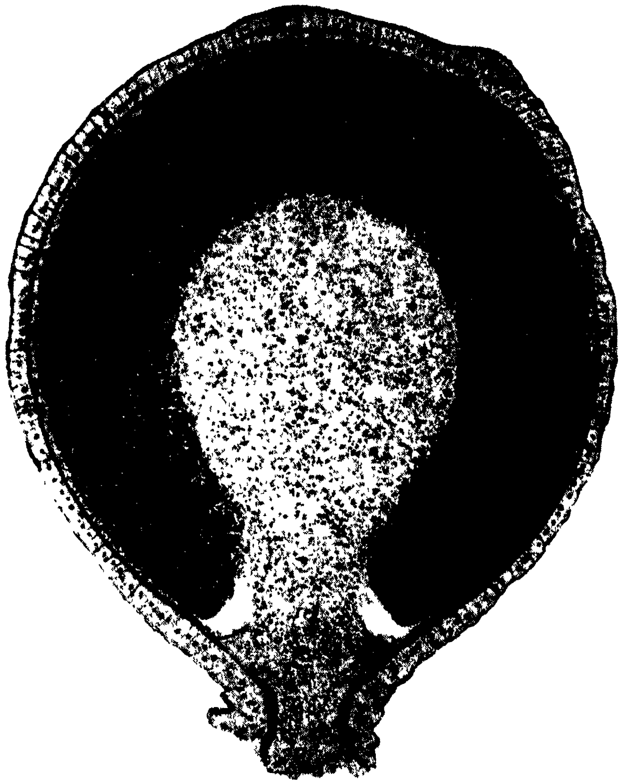

Figure 2.
Myriothela harrisoni. Briggs. Male gonophore with secondary spermatocytes completely filling the sub-umbrellar cavity.

The first stage in spermatogenesis begins in the mass of cells covering the spadix and is accompanied by a rapid multiplication of their nuclei. Then the cytoplasm breaks up and comes to surround each nucleus, forming the spermatogonia in the central part of the mass. These cells are not very unlike those of the gastric endoderm except that their nuclei are slightly larger, and the nucleoplasm appears lighter in colour and less granular. In these respects they agree

with the condition observed by Benoit among the spermatogonia in the central part of the germinal mass, although in *M. cocksi* these cells contained large quantities of nutritive material.

The layer of spermatogonia increases in extent, and by rapid division the spermatogonia give rise to the primary spermatocytes. From these are derived the secondary spermatocytes which completely fill the sub-umbrellar cavity (Fig. 2). They form an extremely compact mass of very small cells measuring only 2 μ in diameter. When viewed in vertical section this mass of secondary spermatocytes has a characteristic horse-shoe shaped form which fits closely over the surface of the spadix. The gonophore (Fig. 2) has now acquired a diameter of 375 μ and is completely covered by ectoderm in which the cells are reduced to a single layer throughout its whole extent. At the distal pole, the raised patch of ectoderm lying directly above the gap between the endoderm-lamellæ becomes invaginated at the centre to form a small pit-like depression which breaks through into the sub-umbrellar cavity. The velar aperture thus established is lined by a deep columnar epithelium whose cells are derived from the ectoderm. In Part I, I have already figured on Plate III, fig. 5, a vertical section through the distal pole of the male gonophore. This shows clearly the condition of the apical opening representing the velar aperture as it occurs at this stage in the development of the gonophore.

The mature male gonophore reaches a diameter of 450 μ and is occupied by an extremely large number of spermatozoa. These completely fill the sub-umbrellar cavity which has increased in size owing to the partial expulsion of the spadix into the gastric cavity of the blastostyle. The spermatozoa have small, intensely chromatic, spherical heads and long lightly-staining tails. They are arranged in bundles with the tails in parallel rows turned in different directions.

In the definitive gonophore, the sub-umbrellar epithelium increases considerably in thickness and the musculo-epithelial cells are produced into short muscle processes which lie close against the inner surface of the supporting lamella. If my interpretation of the function of the velar aperture be the correct one, then these muscle processes by their contraction would aid materially in the discharge of the spermatozoa through this opening at the distal pole of the gonophore.

In the absence of such an opening in the gonophores of *M. cocksi*, the spermatozoa leave the sub-umbrellar cavity of the gonophore and passing down the gastric cavity in the peduncle enter the gastric cavity in the peduncle of the female gonophore and so reach the mature ovum which, at this stage, has not yet been expelled. This passage of the spermatozoa is made possible by the fact that in *M. cocksi* the male and female gonophores are borne on the same blastostyle.

Although my most advanced stages among the male gonophores of *M. harrisoni* are undoubtedly sexually mature, I have never detected spermatozoa in the peduncle of the gonophore or in the gastric cavity of the blastostyle.

Development of the Female Gonophores.

The description of the development of the female gonophores in *M. harrisoni* is based on rather scanty material derived from the only female specimen in the collection. Three stages are represented, the youngest consisting of a small gonophore, 160 μ in diameter, in which the oogonia are clearly discernible. The second stage is slightly more advanced and its sub-umbrellar cavity is filled with closely-packed oogonia and a few primary oocytes. The third stage contains a

number of plasmodial areas with well-defined outlines separated from one another by thin non-cellular partitions which extend from the spadix to the epithelium of the sub-umbrellar cavity.

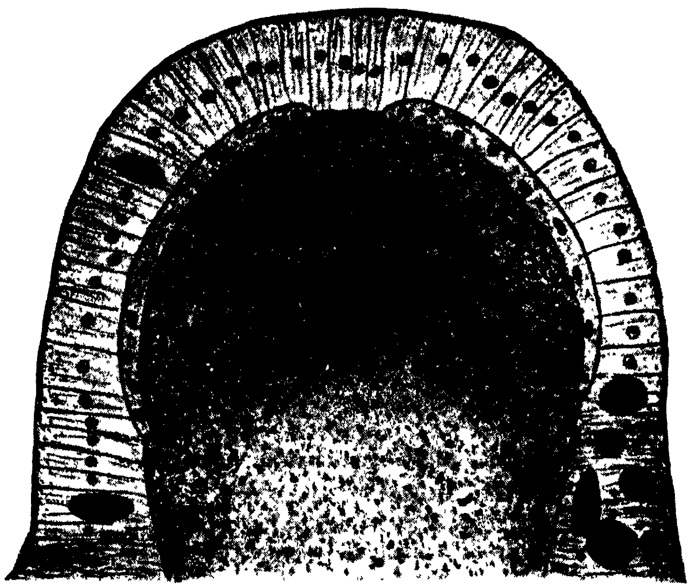

Figure 3
Myriothela harrisoni, Briggs. Female gonophore, Stage I.

Stage I:

In this stage the gonophore is represented by a sessile, sub-spherical body, 160 μ in diameter, in which the ectoderm is reduced to a single layer of columnar cells (Fig. 3). The oogonia completely fill the entire space between the sub-umbrellar epithelium. When viewed in vertical section, the oogonia are seen to be arranged in a crescent-shaped mass with the horns prolonged for a considerable distance over the lateral regions of the manubrium. The gastric endoderm presents a very characteristic appearance due to the development of the villi which completely fill the gastric cavity. The cells are crowded with nutritive spheres probably of a lipoid nature, forming a very important nutritive substance for the development of the gonophore.

Stage II:

The gonophore has now reached a diameter of 300 μ, and is connected with the blastostyle by an extremely short peduncle. The oogonia fill the sub-umbrellar cavity and retain the appearance of a crescent-shaped mass when viewed in vertical section. At the distal extremity of the spadix, some of the oogonia have increased in size to give rise to the primary oocytes which press closely against the other cells and assume a polygonal form. Each primary oocyte consists of a large cell, 24 μ in diameter, with a large eccentrically-placed nucleus of 9 μ

diameter. The nucleolus is 3 μ in diameter, and is formed of dense chromatin. Around the nucleolus is a clear zone beyond which is a fine network of threads carrying numerous chromatin granules.

Stage III:

In this stage there are present in the gonophore some six or seven large plasmodial areas completely separated from one another by thin, non-cellular partitions which extend from the spadix to the epithelium of the sub-umbrellar cavity. By means of these partitions, the sub-umbrellar cavity is divided into a number of chambers each enclosing a plasmodial mass with its very characteristic nucleus which is discernible as an oval, lightly-staining body enclosed by a slightly-wrinkled nuclear membrane. The nucleus has a diameter of 39 μ and occupies an eccentric position just beneath the outer surface of the plasmodial area.

Scattered through the cytoplasm are the Pseudozellen representing the slightly degenerate nuclei of the primary oocytes which were the last to fuse with the plasmodial areas. The cytoplasm is charged with yolk which is of two kinds. There are small, simple yolk spheres and compound yolk spheres which form the largest elements in the plasmodial areas.

Geographical Distribution of Myriothela.

The discovery of two new species of *Myriothela* in the Southern Hemisphere is extremely interesting since the range of the genus must now be extended from the Antarctic circumpolar seas to include the more temperate waters of the coast of New South Wales. Both *M. australis* and *M. harrisoni* occur in the neighbourhood of Lat. 34° South, and their presence in this part of the Pacific Ocean is by no means a fortuitous one since the two species appear to be well-established and exhibit a number of outstanding characters which differentiate them from the other representatives of the genus.

In his discussion on the geographical distribution of the northern species, *M. phrygia*, Broch remarks that "the genus *Myriothela* is recorded from the northern seas and from the Antarctic Ocean. The spread and rare occurrence of the individuals prevents us from deciding whether the genus is in fact bipolar, as the finds hitherto recorded seem to indicate." Although *M. phrygia* is essentially a deep-sea form, occurring mainly in the icy waters of the high Arctic regions, nevertheless there is a record by the "Michael Sars" Expedition that this species was found in the warm Atlantic waters to the south of the Wyville Thomson Ridge which separates the marine faunas in the deep water on either side of this natural barrier. Broch suggests that there is a possibility that the animal had been carried there by the Arctic currents from northern regions. In that event the currents conveyed the animal at an early period of life to the new locality where it was able to subsist and develop further.

The distribution of *M. cocksi* has been confused to a certain extent with that of *M. phrygia*, but the former species is known definitely to occur as a shallow-water form on the coasts of Great Britain and western Europe.

The propriety of referring all four species described by Bonnevie to the genus *Myriothela* is open to some doubt; for the sake of completeness I include them as representatives of the genus in the Northern Hemisphere.

Jäderholm's *M. austro-georgiæ* has a circumpolar distribution in the Southern Hemisphere, occurring at South Georgia, South Orkneys, Booth-Wandel Island, and Kerguelen Island. Hickson and Gravely have recorded the occurrence of *Myriothela* (?) from McMurdo Bay, Antarctica, but the brief description and figure are not sufficient to establish the generic status of their specimen.

The Australian species of *Myriothela* were discovered as a result of shore collecting. The specimens of *M. australis* occurred on the lobes of the thallus of a seaweed at Maroubra Bay, near Sydney, New South Wales, while *M. harrisoni* was gathered on the undersides of rocks below low-water mark at Bulli, forty miles south of Sydney.

The discontinuous distribution of the genus *Myriothela* in the Southern Hemisphere is more apparent than real, since a hitherto undescribed species of *Myriothela* collected by the Australasian Antarctic Expedition at Macquarie Island in Lat. 55° South represents a link in the chain of distribution which begins in Antarctic and Sub-Antarctic seas and extends to the warm coastal waters of eastern Australia.

The occurrence of *Myriothela* in Lat. 34° South, suggests at once the possibility that the specimens are stragglers which have reached the shores of Australia in the currents from the south in much the same manner as *M. phrygia* has been carried into the warm waters of the Atlantic. The Australian species, however, possess such well-marked characters and appear to be so well-established that they support rather the theory of a universal cold sea in earlier geologic times with the subsequent elimination of certain types from the intervening areas as they became warm.

SUMMARY.

1. The development of the male and female gonophores in *M. harrisoni*, Briggs, is described and figured.
2. All the gonophores on a blastostyle are of the same sex, and throughout any one individual the sex of the gonophores is uniform.
3. The mature gonophores are sub-spherical in form, somewhat flattened distally, and are either sessile or very shortly pedunculate.
4. The male gonophore appears as an endodermal evagination which penetrates deeply into the ectoderm. The interstitial cell at the apex of the evagination divides to form a rounded mass of cells which becomes cut off from the rest of the endoderm by a thin, non-cellular layer.
5. A split occurs in the cell-mass where a small eccentrically-placed cavity is formed. This constitutes the *Anlage* of the sub-umbrellar cavity.
6. Spermatogenesis begins in the mass of cells covering the spadix, and spermatogonia, primary spermatocytes, secondary spermatocytes and spermatozoa can be recognized.
7. In the development of the female gonophore, oogonia and primary oocytes are formed.
8. The primary oocytes fuse into cytoplasmic masses which later combine into plasmodial areas each with a definitive nucleus.
9. The plasmodial areas have well-defined outlines separated from one another by thin non-cellular partitions, which extend from the spadix to the sub-umbrellar epithelium.
10. The Pseudozellen represent the degenerate nuclei of the primary oocytes which were the last to fuse with the plasmodial areas.

11. There are two main types of yolk in the egg: (*a*) small, simple yolk spheres, and (*b*) compound yolk spheres which form the largest elements in the egg.
12. The geographical distribution of *Myriothela* supports the theory of a universal cold sea in earlier geologic times, with the subsequent elimination of certain types from the intervening areas as they became warm.

CONCLUSIONS.

1. The Australian species of *Myriothela*, *M. australis* and *M. harrisoni* are diœcious but the development of the gonophores and the formation of the egg follow through a series of stages very similar in their general details to those described for the northern form, *Myriothela cocksi* (Vigurs).

2. The gonophore arises from the blastostyle and its first appearance always begins as an evagination of the endoderm. When the *Glockenkern* is established a split occurs in the cell-mass where a small cavity is formed. This enlarges into a chamber which constitutes the *Anlage* of the sub-umbrellar cavity. The outgrowth of the gastric endoderm gives rise to the manubrium. This forces back the cells on the floor of the sub-umbrellar cavity and the endoderm-lamellæ separate in the axis of the gonophore. From the cells on the floor of the sub-umbrellar cavity are derived the reproductive elements. The definitive gonophore always bears an opening, the velar aperture, at its distal pole.

3. The first stage in spermatogenesis begins in the mass of cells covering the spadix and is accompanied by the rapid multiplication of their nuclei. Then the cytoplasm breaks up and comes to surround each nucleus, forming the spermatogonia in the central part of the mass. By division, the spermatogonia give rise to the primary spermatocytes. From these are derived the secondary spermatocytes which in turn form the spermatozoa with small, intensely chromatic, spherical heads and long, lightly-staining tails.

4. In the female gonophore the cells of the germinal mass are arranged in several layers; those in the outer layer form the external epithelium of the future spadix, while the others represent the mother-cells of the future reproductive elements and form the oogonia. These multiply and increase in size to give rise to the primary oocytes which press closely against one another and assume a polygonal form.

5. The first appearance of egg-formation occurs among the primary oocytes situated in the lower layers of the cell-mass. Here two primary oocytes come into close contact and their cytoplasm fuses to form a small cytoplasmic mass. The sub-umbrellar cavity gradually fills with these cytoplasmic masses which increase in size by accretion of either new primary oocytes, or of previously-formed cytoplasmic masses. The final absorption of all the primary oocytes into these cytoplasmic masses is followed by the fusion of the masses themselves, forming a number of large plasmodial areas completely separated by non-cellular partitions. The definitive egg is produced by the withdrawal of the partitions and the subsequent fusion of the plasmodial areas.

6. The Pseudozellen represent the slightly degenerate nuclei of the primary oocytes which were the last to fuse with the cytoplasmic masses. The cytoplasm of the mature ovum becomes charged with yolk which constitutes the deutoplasm of the egg. There are two main types of yolk: (*a*) small, simple yolk spheres which vary greatly in size, and (*b*) compound yolk spheres which form the largest elements in the egg. There is never any observable connection between the Pseudozellen and the formation of the yolk spheres.

NOTES ON AUSTRALIAN ATHECATE HYDROIDS.

By

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The following notes refer to two Athecate Hydroids—(i) the fresh water *Cordylophora lacustris* Allman, from the Myall Lakes, New South Wales, and (ii) the marine *Bougainvillia ramosa* (van Beneden) from Port Jackson, Sydney.

The occurrence of *Cordylophora lacustris* in the Myall Lakes is extremely interesting, since this widely distributed colonial Hydroid has been recorded previously in Australian waters only from Parramatta, near Sydney (Whitelegge and von Lendenfeld), and from a small tributary of the River Inglis, between Wynyard and Flowerdale, Northern Tasmania (Flynn).

The marine Hydroid, *Bougainvillia ramosa* (van Beneden), which occurs abundantly on the piles of the wharf at Watson's Bay, Port Jackson, is the first representative of the genus *Bougainvillia* to be recorded from the coastal waters of New South Wales.

I. On *Cordylophora lacustris* from Myall Lakes, N. S. Wales.

Genus **Cordylophora** Allman.

Cordylophora lacustris Allman.

? *Tubularia caspia* Pallas, 1771.

Cordylophora lacustris Allman, Monograph of Gymnoblastic or Tubularian Hydroids, Ray Soc., I, 1871–1872, p. 252, pl. iii, figs. *Id.*, Stechow, Zool. Jahrb., Syst., Bd. xxxii, 1912, p. 343 (synonymy).

Cordylophora whiteleggei Lendenfeld, Zool. Jahrb., Syst., Bd. ii, 1887, p. 97, pl. vi, figs. 11–12.

Cordylophora caspia (Pallas), Roch, Zeitsch. für Morph. und Okologie der Tiere, Bd. ii, 1924, p. 350.

Cordylophora fluviatilis Hamilton, Finlay, Austr. Zoologist, v, 3. 1928, p. 258.

During a biological survey of the fresh water Myall Lakes on the north coast, New South Wales, several submerged logs were removed from the water at Bombah Point, a narrow tongue of land between Booloombayt Lake and The Broadwater. An examination of these logs revealed the presence of many small colonies of the widely distributed fresh water Hydroid, *Cordylophora lacustris* Allman.

The lakes, comprising Myall Lake, Booloombayt Lake, and The Broadwater, form a chain of communicating water-ways parallel to the coast and separated from the sea by a strip of land, which varies from a quarter of a mile to three

miles in width. The Broadwater is connected with Port Stephens and the sea by the narrow tortuous channel of the Lower Myall River. The water in the lakes is quite fresh, and is not affected by the rise and fall of the tide in the Lower Myall River. At the time of my visit (September, 1922), the lakes were in flood, and had risen to about three feet above their normal level.

The specimens of *C. lacustris* from the Myall Lakes exhibit very little branching, and reach a height of only 10 mm. Their salient features, however, agree in detail with the descriptions and figures of the European species, which is known to attain most luxuriant development in brackish water. It thrives also in fresh water, although the colonies are there less robust, and the branches are usually considerably reduced compared with specimens from brackish water.

A comparison of my specimens with material received from England leaves no doubt as to their identity with *C. lacustris*. The characters of the trophosome agree in all respects, while the mature colonies bear gonophores, which are indistinguishable from those of Allman's species. I have also compared my specimens with a mounted preparation of *C. whiteleggei*, which I find is in complete agreement with the generally accepted characters of the somewhat variable *C. lacustris*.

The small size of the Myall Lakes specimens is, I believe, to be directly attributed to their occurrence in fresh water. The growth differences in *Cordylophora*, noted by many writers, indicate a very close relation between the increase or decrease in the relative amounts of certain essential salts in the water. This view certainly gains support from the experimental work of Roch, whose comprehensive studies have been directed towards the solution of two very important questions, *viz.*: (1) Within what limits of salinity is it generally possible for *Cordylophora* to live, and (2) Have the individual salts of the surrounding medium an influence on the external form of the colonies?

As a result of Roch's experiments, it is evident that chlorine, sodium and potassium cannot be replaced by other elements in the water. If one of these elements is wanting in brackish water, the colonies die in a very short time. If sulphur is absent, then the formation of gonophores will be prevented, but if magnesium or calcium is lacking, a rank growth of the colonies will be brought about, in conjunction with very free sexual multiplication.

Although an exact chemical analysis of the water in the Myall Lakes is not available, it is very probable that the stunted growth of the *Cordylophora* can be attributed to the presence of calcium salts, which undoubtedly arrest the development of colonies living in fresh and brackish waters.

Synonymy.—A careful examination of the Myall Lakes specimens definitely establishes their identity with *C. lacustris*, nor can I find any characters which separate them from Lendenfeld's *C. whiteleggei*. Consequently, I have arranged the synonymy as above, reducing the status of *C. whiteleggei* to that of a synonym of *C. lacustris*.

I have retained Allman's name, *C. lacustris*, for this species, which Roch identifies with *Tubularia caspia* Pallas, and proposes to call *Cordylophora caspia* (Pallas). Bedot admits that "il est possible que la *Tubularia caspia* de Pallas soit l'espèce à laquelle Allman a donné le nom de *Cordylophora lacustris*, mais cela n'est pas certain, car la description de Pallas est très vague et n'indique aucun caractère permettant de faire une détermination exacte." He concludes, therefore,

that it is preferable to retain the name *Cordylophora lacustris*, and to place among its synonyms *Tubularia caspia* with a query, since the latter appears to be an indeterminate species.

In a recent contribution, "Notes on New Zealand and Australian Gymnoblastic Hydroids," Finlay[1] has attempted to establish the name *Cordylophora fluviatilis* Hamilton, for a brackish water form collected in the Petane (Esk) River, Hawke's Bay, New Zealand. The characters set out by Hamilton agree in their salient features with those of the Myall Lakes specimens, which I regard as identical with *C. lacustris* Allman. Consequently, Hamilton's *C. fluviatilis*, along with *C. whiteleggei* Lendenfeld, falls into the synonymy of Allman's species.

Hargitt (1924), in his paper on the "Hydroids of the Philippine Islands," has described a new species of *Cordylophora*, *C. dubia*, from the Mololas River. Hargitt's material was very poorly preserved, thus rendering specific identification difficult. The discovery of further specimens in the rivers of the Philippine Islands may ultimately prove the specific identity of *C. dubia* with *C. lacustris*. According to Hargitt's description, "the stems were slenderer, hydranths smaller, and gonangia clearly different"—all variable characters when the different growth-forms of *C. lacustris* are taken fully into account, along with the conditions of the habitat.

Occurrence.—The Myall Lakes specimens were collected in fresh water at Bombah Point in the Spring of 1922.

As early as 1885, Whitelegge had exhibited, before the Linnean Society of New South Wales, living colonies as well as mounted preparations of *Cordylophora* from Parramatta, some fourteen miles west of Sydney. These specimens later formed part of the material handed to Lendenfeld, who described them as a new species, under the name of *C. whiteleggei*. According to Lendenfeld's account, the hydroids were collected on Characeæ from the Parramatta River, near Sydney, where "Die Fundfort liegt weit unterhalb den Region des süssen Wassers, wo die Fluth schon deutlich fühlbar ist. Es dürfte daselbst zu Zeiten das Wasser recht salzig sein." This is not in agreement with Whitelegge's statement in his "List of the Marine and Fresh-Water Invertebrate Fauna of Port Jackson and Neighbourhood," that the specimens were found "on the roots of Myriophyllum in the river, Parramatta Park, near the footbridge." In this situation the animals would occur in quite fresh water, since the stream mentioned by Whitelegge is a considerable distance from the source of the Parramatta River.

Lendenfeld, of course, may have had access to other material, and may have supplemented Whitelegge's collections with specimens from the Parramatta River, in which case they would undoubtedly occur in brackish or even salt water, as the greater part of this arm of Port Jackson is certainly subjected to tidal influences.

II. On *Bougainvillia ramosa* from Port Jackson, N. S. Wales.

Genus **Bougainvillia** Lesson.

Bougainvillia ramosa (van Beneden).

Eudendrium ramosum van Beneden, Nouv. Mém. Acad. Bruxelles, xvii, 1844, pp. 41, 56, pl. iv.

Bougainvillia ramosa Bedot, Revue Suisse de Zool., xxxii, Fasc. suppl., 1925, p. 101 (synonymy).

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[1] Finlay.—Austr. Zool., v. 3, 1928, p. 258.

Trophosome.—The characters of the trophosome agree in detail with Allman's description and figures of *B. ramosa* from the English coast. The hydrocaulus attains a height of two inches, and is much branched, forming a profusely ramified colony with a very characteristic, tree-like appearance. The main stem and principal branches are fascicled, but the ultimate branches are monosiphonic. The branching of the colony is somewhat irregular in the proximal region, but towards the distal extremity the branches become arranged in a definitely alternate manner. Each hydranth bears 12 to 14 filiform tentacles arranged in a single verticil around the base of the conical hypostome. The perisarc is continued over the proximal half of the body of each hydranth in the form of a very thin, almost transparent sheath, which is closely adherent to the wall of the polyp.

Gonosome.—The gonophores are carried on moderately long peduncles, which spring from the ultimate branches, on which they occur either singly or in subverticillate groups of three or four. The gonophores, in various stages of development, are present in large numbers; the most advanced ones show clearly the four simple labial tentacles attached to the extremity of the manubrium. Each labial tentacle expands distally into a small capitulum charged with nematocysts.

Locality.—Specimens of *B. ramosa* were first observed in May, 1918, attached to the piles of the wharf at Watson's Bay, Port Jackson. Prior to that date, no representatives of this species had been met with, although the locality was visited frequently, and the piles examined at brief intervals over a period of six years, from 1912 to 1918. The sudden appearance of these colonies suggests that the original specimens were brought by some ship to the shores of Port Jackson, where the liberated medusæ, having completed their life-cycle, gave rise to the fixed stages, which firmly established themselves in these temperate waters.

Since 1918, I have followed the gradual spread of *B. ramosa* in Sydney Harbour; the species has invaded several localities on the northern and southern shores, and by January, 1930, was well established at Circular Quay, where numerous colonies were to be observed in a flourishing condition on the piles of several wharves.

The occurrence of this typical northern species in the coastal waters of eastern Australia raises an interesting point in connection with the problem of distribution. It appears very unlikely that a living colony of *B. ramosa* could be carried to these shores by ocean currents; on the other hand, there is no reason why such a hardy form should not be transported while attached to the bottom of a vessel. Such a mechanical means of dispersal has been recorded by Browne in the case of *Tubularia crocea*, which was brought, in 1895, from Peru to Plymouth Sound.

THE NARELLAN METEORITE: A NEW CHONDRITE FROM NEW SOUTH WALES.

By

T. Hodge-Smith,

Mineralogist, The Australian Museum

(Plate xxvi.)

This stone fell on the night of April 8, 1928, and was found by the son of Mr. G. J. Richardson on the following morning. Unfortunately Mr. Richardson was taken seriously ill just after the finding of the stone, and in consequence its existence was not made known until some nine months later. After such a lapse of time it was impossible to obtain any reliable information from other observers. Mr. Richardson has supplied the following notes, which appeared in the Sydney *Sun* of January 1, 1929:

" 'I was standing at the door of my cottage at about 7.15 p.m. on April 8 [1928], and the purring noise overhead like rushing wind and aeroplane engines led me to believe that a 'plane was flying overhead on the Sydney to Melbourne route. I walked out into a paddock to try to get a view of what I believed to be a 'plane when suddenly the air began to vibrate and I thought I felt a slight concussion. Simultaneously a pony grazing near me tossed up her head and galloped away. I remember a heavy thud and a slight tremble in the ground as I stumbled back into the house.'

"Mr. Richardson explained that he was called outside by some children to see the illuminations in the sky. He arrived too late to see the display but stood at the door for a while. Fully ten minutes elapsed between the time he was called out until the weird sounds began overhead.

". . . In the morning he (Mr. Richardson's son) found the meteorite. It was buried about six inches into the rocky ground within eight feet of the spot where his father was standing the previous night."

In an official letter from Mr. Richardson he further stated that "the light display was seen by many people, and some of my friends had a fine view of it at Port Kembla, but I did not see any light given off by this piece when it struck the earth."

No report of a "falling star" was received from Sydney, which is about thirty-eight miles north of Narellan, the only reports being received from the south coast. Port Kembla is about thirty-one miles S. 20° E. from the spot where the stone fell. From this evidence it would appear that the stone travelled from the S.S.E.

The locality is latitude 34° 3′ South, longitude 150° 41′ 20″ East.

The weight of the stone was 367·5 grammes. It was cut into two portions weighing 189·2 grammes and 146·8 grammes, the remaining 31·7 grammes being used in making micro-slides and chemical analyses, or lost through cutting. The specific gravity is 3·45.

The outer skin is black tinged with vandyke brown, and the lustre is almost dull. There is a distinct line of demarcation between the skin and the unaltered

portion of the stone; the depth of skin reaches a maximum of 0·4 mm. There appears to be a complete absence of lines of flowage, although the skin is somewhat vesicular and the surface in consequence characteristically pitted. The numerous pits are so small as to be indistinguishable with the unaided eye, but are clearly seen with an ordinary pocket lens.

The general shape of the stone is approximately that of an elongated three-sided pyramid with the apex cut off and the base drawn out to an edge. The measurements of the base are 4·5 cm. by 5·5 cm. by 6 cm., while the height is 9 cm.

The colour of the cut surface is mottled grey. The chondrules can be distinguished, and the nickel-iron is fairly evenly distributed, while a few small nodules of troilite stand out conspicuously.

Under the microscope the chondrules are seen to be somewhat scarce and to consist of radiating enstatite. The ground-mass consists of olivine and enstatite, with a little felspar with a refractive index higher than Canada balsam. In addition nickel-iron and troilite occur in small irregular grains distributed throughout the mass. The former shows a tendency in some cases to be arranged in narrow parallel zones. The composition of the felspar is $Ab_{70}An_{30}$, according to the analysis. A partial analysis of the soluble part of the unattracted portion is as follows:

SiO	31·49
MgO	24·44
FeO	27·16

The composition of the olivine is therefore approximately $3Mg_2SiO_4$, $2Fe_2SiO_4$.

For the purpose of analysis a portion weighing approximately 11·5 grammes was used. After grinding, the metallic portion was separated from the powder by means of a small electric magnet, specially constructed for the purpose. The attracted portion weighed 1·0555 grammes, and the unattracted 10·3433 grammes.

The result of the analysis is as follows:

Constituent.	Attracted.	Unattracted.	Bulk Analysis.	Molecular Ratio.
SiO_2	1·73	41·92	38·45	·641
Al_2O_3		2·41	2·20	·022
Fe_2O_3		3 76	3·41	·021
FeO	1·30*	14·41	13·36	·185
CaO	abs.	1·71	1·56	·028
MgO	1·61	22 95	21·11	·528
K_2O		0 27	0·24	·002
Na_2O		0·66	0·60	·010
Cr_2O_3		0·49	0·44	·003
P_2O_5	abs.	0·46	0·41	·003
TiO_2		0·15	0 13	·002
MnO		0·53	0·48	·006
H_2O		0·03	0·02	
FeS	1·42	7·83	7·28	
Fe	76·01	1·65	8·58	
Ni	10·30		1·21	
Co	0·24	0·29	0·02	
Insoluble	7·13			
	99·75	99·52	99·50	

* Calculated to satisfy SiO_2 in olivine molecule.

The following is the mineral constitution, calculated from the bulk analysis:

Orthoclase	1·11	
Albite	5·24	
Anorthite	2·78	
Felspar		9·13
$CaO.SiO_2$	0·93	
$MgO.SiO_2$	31·80	
$FeO.SiO_2$	7·39	
Bronzite		40·12
$2MgO.SiO_2$	14 70	
$2FeO\ SiO_2$	12 65	
Olivine		27·35
Apatite		1·01
Chromite		0 67
Ilmenite		0·30
Troilite		7 28
Iron	8 58	
Nickel	1·21	
Cobalt	0 02	
Nickel-iron		9 81
Fe_2O_3, etc		3 91
		99 58

The ratio of iron to nickel is 6·9, and the ratio of Mgo to FeO in the magnesium silicates is 2·9. Thus the stone belongs to Group 3 (Barota type) of the Chondrites, according to Prior's classification.[1] It would appear to be a white chondrite (CW) of Brezina's classification.[2]

EXPLANATION OF PLATE XXVI.

The Narellan Meteorite

Fig. 1—Side view, showing the characteristic black skin, natural size

Fig 2—End view, showing the pitting of the skin; natural size

Fig 3.—Section cut through the stone, showing the distribution of the nickel-iron, and the chondritic nature of the stone. The black patches are troilite, which is present in nearly the same quantity as the iron Natural size

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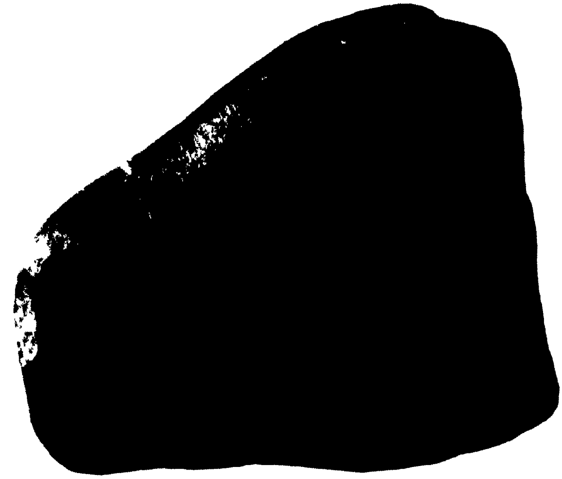
[1] Prior.—Mineralogical Magazine, xviii, 1919, pp. 26-44.

[2] Brezina.—Annalen. des K.K. naturhist. Hofmuseums, x, 1895, pp 232-307.



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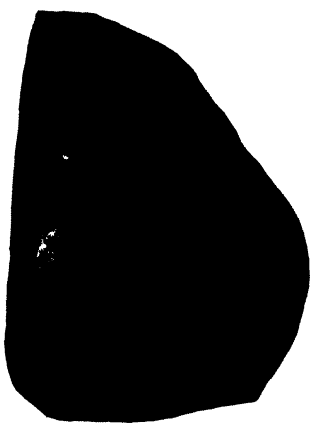

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G. C. CLUTTON, photo.

ON FIVE NEW RATS OF THE GENUS *PSEUDOMYS*.

By

ELLIS LE G. TROUGHTON,

Zoologist, The Australian Museum.

Since the late Oldfield Thomas defined the four subgenera and described three species in 1910, only three additional forms of *Pseudomys* have been recorded. The inference is either that but few races of this interesting genus remain undiscovered, or that individual forms have been accorded far too extensive ranges in the past. For example, two distinct species from Central Australia relegated to coastal forms by Waite, are shown herein to belong to entirely different subgenera and are described as new.

There could be no more definite proof of the value of field work than that a review of the Australian Museum *Pseudomys*, comprising the "old collection", and recent material gained under the inadequate collecting resources now available, revealed interesting and new forms only part of which can be dealt with here.

During 1931 Mr. E. F. Boehm, of Sutherlands, South Australia, submitted young specimens for identification and exchange. Owing to difficulty in sorting out the affinities of immature material, the Trustees secured adults from Mr. Boehm, who accorded permission to describe the form. I am indebted to Mr. A. S. Le Souef for the opportunity to describe specimens from Western Australia; also to Mr. T. Hodge-Smith, Mineralogist and Petrologist to the Museum, who, while on an expedition to the interior in 1930, secured specimens of a form not reported since 1896.

Subgenus **Pseudomys** Gray.

Pseudomys Gray, Proc. Zool. Soc., 1832, p. 39.

Size largest of the genus. Front edge of zygomatic plate evenly concave, with a strong projection above. No antero-internal secondary cingular cusp on m^1 (except as an unusual abnormality).

Type.—*Ps. australis* Gray.

Pseudomys (Pseudomys) minnie, sp. nov.

Diagnosis.—A small-toothed, large-eared form, intermediate between *Ps. auritus* and *Ps. australis*: the ear, hindfoot, and skull decidedly smaller than in the former, and the ear apparently longer, the teeth smaller, and lacking the warm coloration of the latter.

Colour.—Back pale buffy-grey in the male holotype and buffy-brown in the allotype, the tone near "wood brown" (Ridgway), composed of the grey base, pinkish cinnamon upper part and sepia brown tips of the fur. Sides of the female washed with light pinkish cinnamon, which extends along the cheeks and outside of the limbs and contrasts sharply with the undersurface; in the male, probably not fully adult, the coloration of these parts, and generally, is much paler and

the contrast with the undersurface therefore less marked. Undersurface dull white just tinted with pale pinkish buff, grey basally, the general tone not dark enough for the "soiled buffy" of *auritus*. Outwardly the ears are sparsely haired with dark brown in front, and with buffy hairs over the remainder and internally. Manus and pes dull white; a dark brown to blackish patch on the outside and back of the heel. Basal two-thirds of tail above pinkish buff and brown mixed, becoming paler at tip; undersurface dull white.

External characters.—The hindfoot (27–28 mm.) and ear (21·5–23) are definitely smaller than given for *auritus*, 32 and 26 respectively; the ear laid forward just reaches the anterior canthus of the eye and is apparently definitely longer than in *australis*.

Skull and dentition.—The skull is much shorter and considerably smaller in all dimensions, excepting perhaps the interorbital width, than in *auritus*. Palatal foramina apparently shorter than in typical *australis*, not extending beyond the first lamina of m^1, instead of reaching the middle of that tooth, as Thomas indicated for the latter. Teeth shorter than in either ally.

Dimensions of female allotype.—In spirit: head and body, 117; tail, 111; hindfoot, 27; ear, 23.

Skull: greatest length, 30·7; basilar length, 25; greatest breadth, 16·3; nasals, 11·1 × 3; interorbital breadth, 4; breadth of brain-case, 14·3; palatilar length, 15; palatal foramina 7·3 × 1·7; upper molar series, 5·8.

Range.—Minnie Downs Station, in the extreme north-east of South Australia. Dug out of burrows by aborigines and forwarded to Mr. Boehm by Mr. L. von Reon Reese.

Holotype, young adult male, No. M.5195 in the Australian Museum collection, received in exchange from Mr. E. F. Boehm. Allotype, adult female, in the collection of Mr. Boehm.

Remarks.—Thomas stated that *auritus* was the largest of the genus, but his later coastal subspecies, *Ps. australis oralis*, apparently has a longer skull, and definitely larger teeth. The new inland form, however, is a much smaller animal than *auritus*, while the ears are apparently longer than in *australis*, which Thomas said, of the original material, "has the ears of about the normal size".

It is notable that the new form is the most central recorded for the subgenus, and that the paler coloration, smaller teeth and intermediate ear-length may be due to its different habitat to that of the coastal *auritus*, and the more fertile Darling Downs and Liverpool Plains areas from which *australis* and its two synonyms were described. The habitat of *australis* was given on the authority of the donor as "holes in swampy sandy grounds on the south-west or lower side of Liverpool Plains in New Holland"; *lineolatus* was "common in all the open parts of the grassy plains" and "called *Yar-lie* by the natives of the Darling Downs", according to Gilbert, whom Gould quoted. The type of Gould's *murinus* was "procured by Mr. Gilbert on the plains bordering the rivers Namoi and Gwydyr, where the natives informed him it was very abundant".

As it is possible that these slight differences in habitat led to the colour variation described for *australis* and the two synonyms, it is to be expected that specimens from much farther inland should display characteristics of specific importance.

Pseudomys (Pseudomys) rawlinnae, sp. nov.

Diagnosis.—Apparently allied to *Ps. shortridgei*, but the tail proportionately much longer, and the ear and hindfoot longer; the nasals are longer and decidedly narrower, and the teeth are smaller than in the type of *shortridgei*.

Colour.—Above, the general effect is a mottling of light and dark brown, composed of the cinnamon buff of the shorter and sepia tips of the longer hairs; the general tone apparently brighter than the "pale hair-brown with a tinge of buffy" of *shortridgei*. Sides of body and limbs a clearer buffy-brown, washed with light pinkish cinnamon without the mottling of the back, owing to the paling of the brown tips. Undersurface contrasting with the upper, instead of being similar if rather paler and without demarcation as in *shortridgei;* the tips are dull buffy-white and the basal colour is about dark mouse grey. Ears with outer anterior third closely covered with bister hairs, posteriorly almost naked; insides fringed with buffy hairs. Manus white, pes tinged with pale pinkish buff. The well-haired tail is sepia grizzled with buffy-white above, contrasting strongly with the dull white below.

External characters.—Compared with the type of *shortridgei* with a total length 43 mm. longer, the hindfoot and ears are longer; the tail is also proportionately longer, the length 1·1 as opposed to 1·3 in the length of the head and body.

Skull and dentition.—The skull is only 1·2 mm. shorter than that of the type of *shortridgei* with a considerably greater total length. The nasals, however, are longer and decidedly narrower, 12 × 2·9 opposed to 11·5 × 3·7, and the palatal foramina are not narrowly pointed posteriorly, and extend almost to the first lamina of m^1 instead of barely projecting between the front of the roots. Front edge of zygomatic plate quite deeply and evenly concave. Teeth smaller than in *shortridgei*.

Dimensions of male holotype.—In spirit: head and body, 113; tail, 99; hindfoot, 27·5; ear, 21·5.

Skull: greatest length, 30·8; greatest breadth, 16·1; nasals, 12 × 2·9; interorbital, 3·8; breadth of brain-case, 13·7; palatilar length, 14·5; palatal foramina, 7 × 1·4; upper molar series, 5·3; breadth of m^1, 1·8 mm.

Range.—Rawlinna, Trans-Australian Railway, Western Australia, 235 miles east of Kalgoorlie.

Holotype, adult male, No. M.4642, and an immature male, M.4643, in the Australian Museum collection, donated by Mr. A. S. Le Souef, C.M.Z.S.

Remarks.—The new form is doubtless the sub-desert representative of the south-western *Ps. shortridgei* which the collector, after whom it is named, "trapped near water" at 970 ft., in conditions evidently so entirely different from those of Rawlinna, over 450 miles eastward, as to warrant the differences shown above.

Subgenus Leggadina Thomas.

Leggadina Thomas, Ann. Mag. Nat. Hist. (8), vi, 1910, p. 606.

Size small. Anterior zygomatic plate straight or convex in front as in ordinary murines. Molars very variable, but always with a well-marked antero-internal cingular cusp on m^1.

Type.—*Ps.* (*Leggadina*) *forresti* Thomas.

Pseudomys (Leggadina) waitei, sp. nov.

Mus gouldi ? Waite (nec. Waterhouse), Rept. Horn Exped., ii, 1896, pp. 398-403, pl. xxv, fig. 2*a-f*.

Diagnosis.—A small, short-tailed form with unicoloured belly fur, decidedly smaller in all dimensions and differing cranially from the true *Ps. gouldii*. Apparently closely allied to the smaller *Ps. messorius* which differs in having a relatively longer tail and larger skull, longer palatal foramina, and bicoloured belly fur.

Colour.—The holotype male, dried after long preservation and considerably faded: general colour of back sandy buff, about tawny olive, composed of pale cinnamon buff pencilled with the darker tipping of snuff brown, the latter accentuated on the crown; on the cheeks, sides of body and limbs the cinnamon buff is paler and clearer owing to reduction of the darker tipping, but still strikingly contrasted with the creamy white undersurface, the fur of which is not bicoloured, but is whitish from base to tips. Hands and feet buffy-white. Tail brownish above, buffy-white below. Anterior outer margin of ear cinnamon brown, contrasting with body fur.

A recently collected adult female from the Hart Range near Alice Springs, according well with the dimensions of Waite's females, indicates that a medium brown tone (about snuff brown) with a suffusion of pale ochraceous salmon is typical of the living coloration, rather than the pale sandy buff tones following long preservation.

External characters.—As Waite remarked, the Alice Springs series were smaller in all dimensions than *gouldii*, especially the hindfoot range of 16–17·8 as opposed to 25·5, the latter including the negligible claw-length. The holotype male, which is topotypical and possibly of the original collection from Alice Springs, agrees in colour and general appearance with two immature mounted specimens of the original series; the dimensions accord perfectly with those of Waite's males, and the ear, likewise, when laid forward does not reach the eye, but to slightly under 2 mm. from the posterior canthus. The hairs of the tail are long, almost concealing the scales.

Skull and teeth.—Characters of the holotype, as indicated by Waite's description and illustration of the zygomatic plate and m^1, typical of the subgenus *Leggadina*, and not of *Thetomys*, to which *gouldii* belongs. Dimensions and appearance agreeing well with Waite's presentation, excepting his measurement for the male upper molar series, which seems contradictory and is possibly intended for 4 instead of 5 mm.; the palatal foramina projecting further posteriorly than in the figure, reaching the level of the inner corners of the secondary cingular cusp. Palatal foramina shorter than in *messorius*, and apparently less narrowed and not projecting so far posteriorly.

Palate-ridges.—As described by Waite, three complete predental and five divided interdental ridges, the fourth reduced to a tubercle on each side. The Hart Range female differs in both the angulation of the interdentals and in having the fourth ridge fully-developed, a variation which may be sexual, but must remain doubtful until examples of both sexes taken jointly can be examined; Waite unfortunately did not designate the sex or discuss the variation of his specimens.

Dimensions of holotype.—In spirit: head and body, 83; tail, 59; hindfoot, 16·5; ear 12.

Skull: Greatest length, 22·6; condylo-incisive length, 21·8; zygomatic breadth, 12; nasals, 7·6 × 2·3; interorbital, 3·5; breadth of brain-case, 11·1; palatilar length, 11·2; palatal, 12·5; pal. foramina, 5·3; upper molar series 4·1, lower 3·6 mm.

***Range.*—Alice Springs area, Central Australia.**

Specimens examined.—The holotype male, No. M.5194, in the Australian Museum collection, and a paratype male. An adult female from the Hart Range, E.N.E. of Alice Springs, collected by Mr. T. Hodge-Smith, Mineralogist and Petrologist to the Museum, has a longer ear and differences in palatal arrangement which may be mere variation, the scope of which cannot be checked on present material.

Remarks.—The habitat of *Ps. gouldii* was given as "New South Wales" by Waterhouse, but Gould in his "Mammals of Australia" stated that : "The original example . . . . was probably from Mr. Coxen's collection, made either on the Upper Hunter or on the interior side of the Liverpool Range." He also refers to seeing specimens from the Liverpool Plains, from "between the River Courong and Lake Albert", South Australia, and "the neighbourhood of Moore's River, in Western Australia", thus affording the species an impossible range. In view of the disparities in habitat, and in the dimensions noted by Waite, it is surprising that he hesitated to name the Alice Springs form and regarded it as doubtfully identical with the larger coastal *gouldii.*

In "The Mammals of South Australia" Wood Jones refers to the Coorong examples of Gould, and remarks that so far as South Australia is concerned, *gouldii* appears to be a lost animal. However, as Thomas (A.M.N.H., 1921) carefully selected the lectotype from the Hunter River, N.S.W., and, as with *Ps. auritus* and its allies, the Coorong specimens were doubtless quite different, it seems evident that the range of *gouldii* has never extended to South or Central Australia.

As with many desert forms, the Alice Springs series exhibits disparity in the size of the sexes, the males averaging smaller externally. The new species is most nearly allied to *Ps. messorius*, described by Thomas (A.M.N.H., 1925) from Melrose, Spencer Gulf, and near Lake Frome, South Australia, but has a relatively smaller skull, the dimensions averaging less than in the holotype male *messorius*, which has a 22 mm. shorter total length; the palatal foramina are shorter, the tail proportionately longer, and the belly fur entirely white instead of bicoloured.

The name of the late Edgar Ravenswood Waite is associated with this interesting form as a small tribute to the work in mammalogy which he carried out so thoroughly.

Pseudomys (Leggadina) hermannsburgensis Waite.

Mus hermannsburgensis Waite, Rept. Horn Exped., ii, 1896, pp. 405-6, pl. xxvi, fig. 5*a-f*.

In his introduction Waite stated that most of the mice referred to in the Report were not obtained at the time the Horn Expedition visited the McDonnell Ranges, but that Professor Spencer collected quite a large number later, the entire collection subsequently being submitted to him. Part of this collection, including types, was presented to the Australian Museum, the mammal register containing this entry: "The balance of the specimens were returned to Professor Spencer; one of each species (the type) being retained.—E.R.W."

Selection of lectotype.—A holotype was not selected in the report, but in the Museum register Waite entered "specimen D in paper" as type. Unfortunately two specimens bear the one number, specimen D not being indicated, or the sex determinable in the mounted animals. Of the two co-types, however, it seems evident that the larger represents Waite's "type" and it is accordingly selected as the lectotype, No. M.1070A, in the Australian Museum.

Amongst recent acquisitions are specimens from several localities along the Trans-Australian Railway which, compared with the lectotype, appear to represent a definable race, as follows:

Pseudomys hermannsburgensis bolami, subsp. nov.

Diagnosis.—Proportions of head and body and tail as in typical form, but coloration less warm, and the hindfoot and ear consistently larger.

Colour.—Not so warmly brown as in the above co-types and, though these are faded by display, it seems improbable that such bright tones could result from similar fading in the more drab coastal race. General colour of back about Saccardo's umber, composed of cinnamon buff fur-tips and the plentiful dark pencilling, from crown to rump, of longer mummy brown hairs. Cheeks and sides of limbs and body washed with light ochraceous buff, sharply contrasting with the white undersurface. Basal fur very dark above, about blackish slate; below, only basal third of fur is of a much paler grey. Ear with outer anterior third clove brown, whitish haired within. Manus white, pes buffy white. Tail bister above, pinkish buff below. The holotype female, skinned from spirit, has a more pinkish cinnamon tone above, and a yellowish tinge below, possibly influenced by preservation.

External characters.—Ear and hindfoot longer, 15–16·5 opposed to 11–12·5, and 19·3–20 opposed to 17–17·5 mm. respectively. The ear is noticeably longer and broader than in co-types of the typical form; laid forward they reach slightly beyond the eye instead of not surpassing its centre.

Skull and teeth.—Dimensions inclined to intergrade, but the interorbital width averaging larger, 3·8 against 3·3–3·5; palatal foramina averaging slightly longer and projecting back to a level with the first lamina of m^1 instead of to its front level. Upper molar series slightly heavier.

Dimensions of holotype.—In spirit: head and body, 87; tail, 88; hindfoot, 19·5; ear, 16.

Skull: Greatest length, 23·7; basal length, 19·7; zygomatic breadth, 12·3; nasals, 7·9 × 2·4; interorbital, 3·8; breadth of brain-case, 11·4; palatal length 11·8, foramina 4·8; upper molar series 3·7, lower 3·5 mm.

Range.—Ooldea, Fisher, and Rawlinna, along the Trans-Australian Railway in South and Western Australia.

Specimens examined.—The holotype female, No. M.4938, and several spirit and dried specimens, collected at Ooldea by Messrs. Troughton and Wright, and specimens from Fisher and Rawlinna donated by Mr. A. S. Le Souef, C.M.Z.S.

Remarks.—In his Mammal Handbook, Wood Jones referred to the form occurring around Ooldea as "slightly larger than the type specimens", but the dimensions of the ear and pes of my material average decidedly larger than those listed as

captured by Mr. A. G. Bolam. Deeply interested in the sub-desert fauna around Ooldea while stationmaster there, Mr. Bolam greatly assisted collecting activities and has written an interesting account of the district.

Subgenus Gyomys Thomas.

Gyomys Thomas, Ann. Mag. Nat. Hist. (8), vi, 1910, p. 607.

Size small to medium. Anterior zygomatic plate much as in *Leggadina*, the front edge either convex, straight or slightly concave, but never markedly concave as in the other two subgenera. Molars of the normal murine shape; never with an antero-internal cingular cusp on m^1.

Type.—*Ps.* (*Gyomys*) *novæ-hollandiæ* Waterhouse.

Pseudomys (Gyomys) desertor, sp. nov.

Mastacomys sp., Waite, Rept. Horn Exped., ii, 1896, pp. 406-8, pl. xxvi, fig. 6*d-f*, and Proc. Roy. Soc. Vict. (n.s.), x, 2, 1898, p. 128.

Mus nanus Waite. (*nec*. Gould), Proc. Roy. Soc. Vict., n.s., x, 2, 1898, pp. 127-8, pl. vi, fig. 4*a-d*.

Pseudomys (*Thetomys*) *nanus* Wood Jones, Handbook Mamm. South Austr., pt. 3, 1925, pp. 314-5. (Central Australian specimens only.) Not *Ps. nanus* Gould.

Diagnosis.—The only known Central Australian representative of the subgenus; the subgeneric characters separate it from *Ps.* (*Thetomys*) *nanus* to which it bears a close external resemblance.

Colour.—General tone of back about tawny-olive, composed of the cinnamon buff fur-tips and plentiful pencilling of argus brown longer hairs; becoming clearer on the sides owing to the increase of the buffy tone and decrease of the darker element. Undersurface buffy-grey, rather than greyish white as described for *nanus*; on the centre of the belly there is an unusual repetition or washing of the brownish of the back, and there is no conspicuous whitish patch beneath the tail. Anterior outer margin of ear cinnamon brown. Manus and pes warm buffy; the dark mark on the foreleg mentioned by Waite appears to be a continuation and deepening of the brown coloration of the upper limb. Tail above light argus brown, below light buff.

The holotype and paratype, as described above, faded by spirit and exposure to light, are of a clearer brown than Gould's figure of *nanus*, but were probably very similar when fresh. There is, however, no mention or trace of the dark wrist-mark in Gould's description or figure, while Waite did not refer to the undersurface colour as forming a whitish patch beneath the tail.

General characters.—The ear is relatively small, the hindfoot stout, and the hairs of the tail tend to form a brush at the tip. The front edge of zygomatic plate, in the holotype, straight, not evenly concave as in Waite's figure, and the palatal foramina comparatively short and not projecting between the molar rows, more tapered posteriorly than in the figure. Molars normally murine in shape, without any trace of an anterior cingular cusp on m^1.

Palate-ridges.—Three predental undivided; five divided interdental, the first arising at the corner of the anterior cusp of m^1 and the last at the antero-internal cusp of m^3, the last two less evenly arched.

Dimensions of mounted holotype.—Tail, about 88; hindfoot, 21·5; ear, 11·5. For additional dimensions, see Waite's description.

Skull: Greatest length, 27·4; nasals, 9·5 × 3; interorbital, 3·8; brain-case breadth, 12·9; palatal length 14·1, foramina 4·4; upper molar series 5·1, lower 4·9; length of bulla, 5·4 mm.

Range.—Locality of holotype and paratype given in Museum register as Central Australia, but they are undoubtedly of the original series, the localities of which were listed by Waite as Wycliffe Creek, Barrow Creek, and Alice Springs, Central Australia.

Specimens examined.—The holotype, No. M.1306, and paratype, M.1307, in the Australian Museum collection; both are mounted specimens, the sex of which was unfortunately not noted. Presented by Professor Baldwin Spencer.

Remarks.—The external similarity which led Waite to associate this Central form with the Western Australian *nanus* is entirely discounted by differences in subgeneric character shown by the skull and teeth. It may be noted that Wood Jones's description of *nanus* combines characteristics of both forms, namely, the dark wrist-mark apparently characteristic of *desertor*, and the more whitish belly colour of *nanus* which forms a conspicuous patch under the tail.

The Central Australian specimens appear to represent a very distinct species, the fourth known of the subgenus and the only one occurring in the Central region according to present knowledge.

ARAIGNÉES RECUEILLIES EN NOUVELLE-CALÉDONIE PAR M. T. D. A. COCKERELL.*

Par

LUCIEN BERLAND.
Muséum d'Histoire Naturelle, Paris.

(Figures 1-6.)

Au cours d'un voyage fait en Nouvelle-Calédonie en juin, 1928, M. T. D. A. Cockerell, de l'Université de Colorado (U.S.A.), a recueilli une petite collection d'Araignées qui fut donnée au Musée de Sydney. Cet établissement a bien voulu m'en confier l'étude, ce dont je le remercie vivement, et j'en donne ci-après la liste.

Ce matériel, réparti en 23 espèces, présente un certain intérêt, et ajoute sensiblement à nos connaissances sur la faune aranéenne de l'île. M. Cockerell a eu la chance de capturer plusieurs espèces rares et assez mal connues, telles que *Epimecinus nexibilis*, *Tetragnatha noumeensis*, *Araneus noumeensis*, *Clubiona canaca*; d'autres déjà connues de terres voisines, mais nouvelles pour la Nouvelle-Calédonie: *Chiracanthium gilvum*, *Oxyopes gregarius*; enfin deux espèces doivent être considérées comme nouvelles, une Drasside que je me fais un plaisir de dédier à M. Cockerell, *Hypodrassodes cockerelli*, et une Salticide, *Holoplatys caledonica*.

LISTE DES ESPÈCES.

Stenygrocercus silvicola (E. Simon), île Ouen, 1 ♀ jeune.
Uloborus geniculatus Olivier, Bourail, 1 ♀.
Epimecinus nexibilis (E. Simon), Plum, 1 ♀.
Scytodes marmorata L. Koch, Bourail, 1 ♀.
Hypodrassodes cockerelli, n. sp., Plum, 1 ♀.
Smeringopus elongatus (Vinson), Bourail, 1 ♀.
Latrodectus hasselti Thorell, Plum, 1 ♀.
Tetragnatha noumeensis Berland, Plum, 2 ♂.
Leucauge granulata (Walckenaer), Plum, 1 ♂.
Nephila plumipes (Latreille); diverses localités, plusieurs ♀ jeunes, 1 ♂.
Argiope ætherea (Walckenaer), Bourail, 1 ♀ jeune.
Cyrtophora moluccensis Dol., diverses localités.
Araneus flavicoma (E. Simon), Plum, 3 ♀ jeunes.
Araneus theisi (Walckenaer), Bourail, 2 ♀ très jeunes.
Araneus noumeensis E. Simon, Bourail, 1 ♀ entièrement blanche.

* Some time ago Professor T. D. A. Cockerell presented to this Museum a series of spiders collected by him in New Caledonia. Being subsequently in Paris, he met M. Lucien Berland, who for several years has worked on the spiders of the Pacific and particularly of New Caledonia, and advised him to communicate with the Australian Museum regarding this collection. At M. Berland's request the collection was forwarded to him for examination and description. The Trustees of this Museum are indebted to him for this contribution.—EDITOR.

Araneus canalæ Berland, Nouméa, Plum, Bourail, plusiers ♀ présentant des variations de couleurs, voir plus loin la remarque à ce sujet.

Chiracanthium gilvum L. Koch, Nouméa, 2 ♀.

Clubiona canaca Berland, Bourail, 1 ♂.

Dolomedes sp ?, Bourail, 1 individu très jeune.

Lycosa konei Berland, Bourail, 2 ♀.

Oxyopes gregarius Urquhart, Plum, 2 ♂ jeunes, Bourail, 2 ♀ jeunes. L'espèce est décrite de Nouvelle-Zélande; j'ai récemment donné son nom à des *Oxyopes* trouvés à Lifou (îles Loyalty); la détermination rigoureuse des exemplaires de Nouvelle-Calédonie n'est pas possible, car aucun d'entre eux n'est adulte, toutefois j'ai de fortes raisons de croire qu'il s'agit bien de *O. gregarius*, qui se trouverait ainsi en Nouvelle-Zélande, en Nouvelle-Calédonie, et aux Loyalty.

Rhondes neocaledonicus (E. Simon), Plum, plusieurs jeunes.

Holoplatys caledonica, n. sp., Bourail, 1 ♂, 1 ♀.

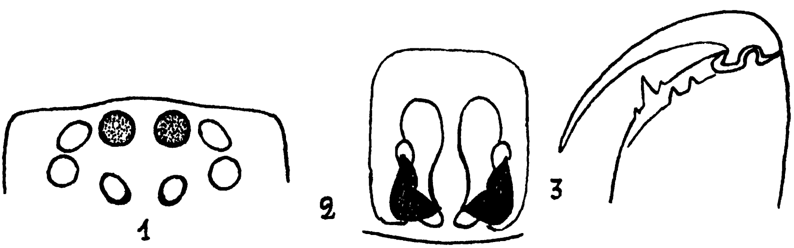
Description des Espèces Nouvelles et Remarques Diverses.

Hypodrassodes cockerelli, n. sp.

(Figs. 1, 2, 3.)

♀. Couleur: céphalothorax fauve clair, les yeux médians antérieurs avec une grosse tache noire triangulaire dirigée postérieurement, les latéraux des deux lignes dans une tache noire; chélicères fauve clair; pièces buccales, sternum pattes et filières jaune paille, le sternum finement liseré de brun; abdomen gris souris avec une tache jaune lancéolée au dessus du vaisseau dorsal, et de fines écailles nacrées par ci par là.

Yeux (Fig. 1): 1re ligne droite vue de l'avant, les médians plus gros que les latéraux, plus séparés entre eux (½ diamètre à peine) que des latéraux, qui les touchent presque; 2e ligne procurvée, les médians arrondis, plus petits que les latéraux, et plus séparés entre eux (1 diamètre) que des latéraux; groupe des médians aussi long que large, et carré, latéraux des deux lignes à peu près contigus.



Figures 1-3.
Hypodrassodes cockerelli, n. sp—1, groupe oculaire; 2, épigyne; 3, chélicère.

Chélicères un peu géniculées à la base, armées de 3 dents, dont les latérales, très petites, à la marge antérieure, 2 petites dents à la marge postérieure.

Sternum en écusson, droit en avant, bombé, avec une bosse en face de chaque hanche.

Pattes IV-I-II-III, armées dépines fines et noires, nombreuses aux pattes III et IV, beaucoup moins aux antérieures: fémurs avec 2 antéro-apicales, 1 supéro-apicale, tibias avec 1 inféro-médiane, 1 inféro-apicale, métatarses avec 2 inféro-subbasales.

Epigyne en grande plaque (Fig. 2).

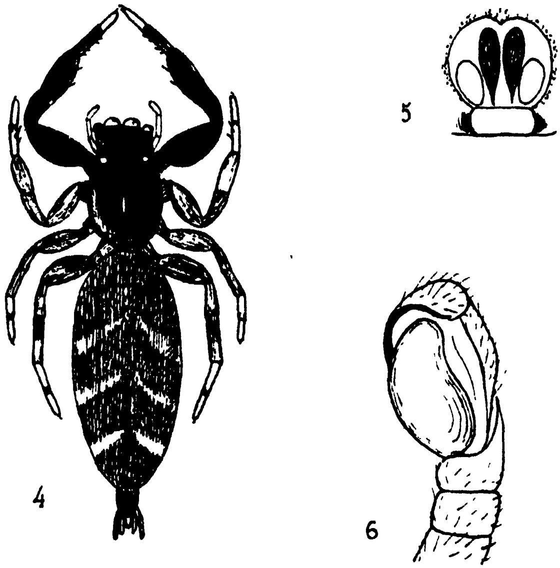
Dimensions: longueur totale, 4·8 mm., céphaloth.; longueur, 1·8, largeur, 1·5 mm.

Plum, juin, 1928, 1 ♀ (holotype, dans la collection de l'Australian Museum).

Le genre *Hypodrassodes*, crée il y a peu d'années par le comte de Dalmas pour des espéces jadis rangées dans le genre *Drassodes*, est spécial à la Nouvelle-Zélande et à la Nouvelle-Calédonie; il est caractérisé par la forme et la disposition des yeux, et par la présence sur le corps d'écailles à reflets nacrés; l'individu trouvé par M. Cockerell ne pouvait être rapporté à aucune des espèces connues, et son épigyne, en particulier, a une forme bien spéciale.

Holoplatys caledonica, n. sp.
(Figs. 4, 5, 6.)

♀ (Fig. 4). Couleur: céphalothorax entièrement noir, avec quelques poils blancs formant une ligne peu visible sur les côtés chélicères, pièces buccales (l'apex des lames-maxillaires blanc) sternum noirâtres; pattes-mâchoires jaune



FIGURES 4-6.
Holoplatys caledonica, n. sp.—4, ♀ × 8; 5, épigyne; 6, organe copulateur mâle.

clair; pattes: I brun de poix sauf les tarses qui sont jaune clair dans la moitié apicale, les autres pattes brun plus ou moins clair, les tarses blanc jaunâtre ainsi que la face inférieure de tous les articles, métatarses blanc jaunâtre, brunis à l'apex; abdomen gris-brun, plus clair que le céphalothorax, avec 3 accents clairs transversaux formés par le tégument mais revêtus d'écailles blanches, le dernier de ces accents seul est bien net, les autres sont à peine visibles; filières et tubercule anal bruns.

Caractères généraux des *Holoplatys*: céphalothorax très plat partie céphalique indistincte: pattes 1 robustes et à articles dilatés, surtout les fémurs; mais cette espèce s'en distingue par: 2 petites épines obtuses au tibia 1, semblables à celles du métatarse (les tibias 1 sont le plus souvent inermes dans le genre *Holoplatys*, mais quelques espèces présentent des épines, de sorte que ce caractère ne peut être considéré comme ayant une valeur générique absolue), abdomen prolongé postérieurement en un petit tubercule bien net portant les filières et un tubercule anal bien développé; en outre la taille est relativement faible.

Epigyne (Fig. 5).

Dimensions: longueur totale, 6 mm., céphaloth., longueur 2 mm., larguer, 0·9 mm.

Bourail, 1 ♀ (holotype, dans la collection de l'Australian Museum).

♂. Comme la femelle en coloration et aspect général, mais encore plus grêle et taille plus faible; patte-mâchoire; Fig. 6.

Dimensions: long. tot. 4 mm., céph. long. 1·7 mm., larg. 0·9.

Bourail, 1 ♂ (type du mâle, allotype, dans la collection de l'Australian Museum).

Le comte de Dalmas a fait remarquer que l'on avait indiqué à tort *Holoplatys planissima* (L. Koch) comme existant en Nouvelle-Zélande. Je crois maintenant qu'il en est de même pour la Nouvelle-Calédonie. Après E. Simon, j'en avais signalé cette espèce sur un jeune individu, mais le couple trouvé par M. Cockerell montre qu'il s'agit d'une autre espèce, jusqu'à présent inconnue, et probablement spéciale à la Nouvelle-Calédonie. *H. planissima*, sans doute uniquement australienne, est de taille plus forte, présente sur l'abdomen deux sillons longitudinaux bien nets, et a des organes copulateurs différents.

Araneus canalæ Berland.

L'espèce a été décrite sur deux femelles seulement. Les cinq exemplaires recueillis par M. Cockerell montrent une variation de couleur assez étendue et qui mérite d'être signalée.

La coloration du céphalothorax, des pattes et de la face ventrale est peu variable: notamment les deux taches blanches longitudinales du ventre de l'abdomen sont constantes. Mais l'abdomen par ailleurs varie beaucoup, sa couleur fondamentale paraît être le blanc pur, auquel s'ajoutent, en plus ou moins grande proportion, des dessins brunâtres sur la face dorsale, qui peuvent être de couleur rouge violacé à l'origine (cette couleur disparaissant probablement dans l'alcool); ces dessins sont constitués en général par trois taches antérieures, 1 médiane et 2 latérales, suivies dans la moitié postérieure par 1 bande médiane lancéolée et un folium à côtés sinueux: c'est ce que j'ai figuré jadis pour le type; mais la couleur foncée se réduit progressivement jusqu'à ce que les taches ne soient plus constituées que par des linéoles; dans un exemplaire de Plum les trois taches antérieures ont disparu, et parmi les trois exemplaires de Bourail, l'un a les dessins très réduits, les deux autres également, mais avec adjonction de chaque côté d'une grosse macule noire; enfin l'exemplaire de Nouméa a l'abdomen entièrement blanc, avec une vague indication de dessins dans la partie postérieure, et des fascies grises sur les flancs.

Ce qui est constant, c'est la taille (6 mm.), la forme subtriangulaire de l'abdomen avec la base en avant et le sommet postérieur, ainsi, bien entendu, que la forme de l'épigyne. Une variation semblable me parait exister chez *Araneus noumeensis*; elle est indépendante du milieu, ou tout au moins de la localité, car d'après le matériel récolté, on peut trouver en même temps des individus très diversement colorés.

DESCRIPTION OF A NEW SPECIES OF *LYGOSOMA* FROM NORTH-WEST AUSTRALIA.

By

J. R. KINGHORN, C.M.Z.S.
Zoologist, The Australian Museum.

(Figure 1.)

The lizard described below formed part of a small but interesting collection made by Mr. David G. Stead, in the Carnarvon district, north-west Australia, during the third quarter of the year 1929, all the specimens being presented to the Trustees of the Australian Museum.

Lygosoma (Hinulia) breviunguis, sp. nov.

Body slender, the distance between the end of the snout and the forelimb contained twice between the axilla and the groin. The snout is somewhat depressed, the canthus rostralis rounded, but the loreal region is nearly vertical. Lower eyelid scaly. The nostril pierced in a nasal, which is divided vertically, the lower suture joining the first labial, the upper in contact with the upper part of the anterior loreal, which is large, and curved on to the snout. There are no supranasals, the nasals forming a broad suture, thus widely separating the prefrontal from the rostral which is low and band-like. The prefrontals also form a broad median suture. The frontal is long and tapering; it is longer than its distance from the end of the snout and from the posterior border of the parietals, while its greatest width is slightly greater than that across the second supraocular, and about equal to the distance across the third. The frontoparietals are distinct and larger than the interparietal, the parietals forming a short median suture posteriorly. There are four supraoculars, the second being the largest, the three anterior ones being in contact with the frontal. There are nine supraciliaries, the first being the largest. Eight lower and eight upper labials, the sixth and seventh being below the eye; three temporals, the one joining the parietal being much the largest. Three distinct nuchals. Ear opening oval, about as large as the eye opening, the anterior border bearing four obtusely pointed lobules, the central pair being much the largest. The scales, which are smooth, are in thirty-six rows round the centre of the body, the laterals being smaller than the ventrals and dorsals, which are about equal in size. The adpressed limbs barely meet; the digits are rounded above, and keeled below, the keels being on the lamellæ, of which there are twenty-seven under the fourth toe. The claws are short and blunt. The tail is slightly compressed and nearly twice as long as head and body. There are two enlarged anal scales.

Colour (spirits).—Upper surfaces a rich brown with several longitudinal series of rectangular blackish marks, each bearing a white central line. The markings on the sides are somewhat larger than those on the back, with the white predominating, the lowest marks being irregular in shape, somewhat rounded, the black being almost absent. There are a few irregular spots on the occipital region and hind neck, and some round white ones between the shoulder and the sides of the head. There is a distinct black-bordered, white mark below and immediately behind the eye. On the tail the markings are black, and there is a fairly distinct, black-bordered, white, lateral line. There are some spots under the chin and under the tail, the remainder of the lower surfaces being immaculate.

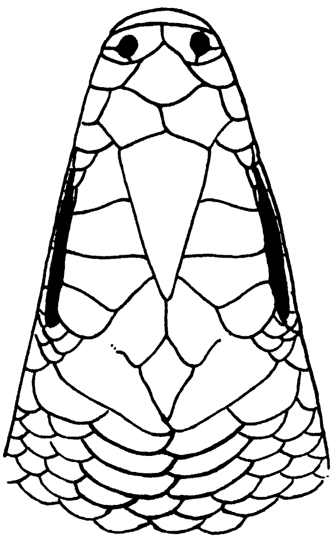


Fig 1.—*Lygosoma (Hinulia) breviunguis*, sp. nov

Measurements.—Total length, 237 mm.; head, 15 mm.; width of head behind eyes, 9 mm.; length of body, 70 mm.; tail, 152 mm.; fore limb, 22 mm.; hind limb, 31 mm.; axilla to groin, 53 mm.

Locality.—Carnarvon district, North-west Cape, North Australia.

Holotype, No. R.9981, in Australian Museum.

Described from a single specimen collected by Mr. David G. Stead in August, 1929.

Affinities.—*L. breviunguis* appears to be more closely allied to *L. lesueurii* than to any other species of the group, but is distinguished by the following characters: Thirty-six rows of scales, the rostral widely separated from the prefrontal by the junction of the nasals; the dorsal scales are subequal; the limbs do not overlap; the claws are very short and the digital lamellæ are keeled.

ETHNOLOGICAL NOTES.

No. 4.

By

W. W. THORPE,
Ethnologist, The Australian Museum.

(Plates xxvii-xxxii.)

Basalt Hammers, or Pounders.

Through the courtesy of Messrs. Roy Mackenzie and Rex Burns, residents of Mangrove Mountain, some twenty miles west of Gosford, New South Wales, the writer was enabled to dig up, or acquire by gift, several rectangular hammers or pounders, invariably of basalt, of a type hitherto undescribed. The writer was already acquainted with this type of implement, there being several examples already in the Museum cabinets, but of which little was known.

The Trustees possess two from Bulga, Singleton district, New South Wales (registered numbers, E.24709 and E.26035), one from a rock shelter on Wyong Creek, New South Wales (E.11247), and another, not otherwise included, from Mangrove Mountain (E.33473). To these may be added some seven specimens from the collection of the late R. H. Mathews (E.25660-66). These latter were received in an undocumented condition. The locality, "New South Wales", was all the information available, but being also composed of basalt, and knowing that Mathews in his capacity as surveyor spent a good deal of time in the Singleton district, it may be allowed that his specimens were from that area, or southward to the Hawkesbury-Brisbane Water system.

Being associated with the finding of three such implements in a rock shelter, including one of especial interest, induced the writer to figure these relics in this paper. The specimen specially referred to (Plate xxvii, fig. 8), though smaller than the average, still retains the gum cement binding and stringy-bark packing which goes to prove that these implements were sometimes, if not always, hafted.

The three figured specimens (Plate xxvii, figs. 1, 3 and 8) were disclosed at a depth of eighteen inches, in the ashes, soil and debris accumulated in a sandstone rock shelter. Many others are known from the Mangrove Mountain area, and, almost without exception, found at a shallow depth, close to the back wall, which makes it appear that they had been cached by the owners.

The presence also of basalt chips in the rock shelters of that area seems to indicate that this material was used for knives and scrapers. This belief is supported by the almost entire absence of siliceous flakework. In this regard, mention should be made of the discovery of odd scarifiers[1] found so abundantly

[1] Etheridge, R., and Whitelegge, T.—REC. AUSTR. MUS., vi, No. 4, 1907, p. 238.

on our coastal middens. Although the district is geologically Triassic, and abounding in sandstone, the writer was shown an outcrop of basalt boulders, which tends to prove that the material for these pounders was locally obtained.

The dimensions of these specimens are recorded in the explanations to plates at the close of this paper. Two examples (Plate xxvii, figs. 1 and 3) are much alike. They have been flaked down from a larger mass, and been subjected to a smoothing process. The heavier ends show the effects of pounding. There is nothing approaching a cutting edge on either. That the makers were acquainted with the stone axe is undoubted, as a description of several from this area will follow. The definite use of these pounders is still a matter for conjecture. Some of those in the Mathews collection were originally axes, but being used for pounding, they could no longer serve for cutting.

Another specimen (Plate xxvii, fig. 7) was found on the surface at the entrance to a shelter. It is shorter and stouter than the preceding, and all four sides show evidence of use.

The example at one time hafted (Plate xxvii, fig. 8) is much smaller, irregular in shape, and flatter than others. It appears to be a natural block of basalt, and shows wear at both ends.

Massive Flaked Choppers.

In 1928, the writer had the good fortune to discover at Morna Point, south of Port Stephens, New South Wales, several large flaked stone implements, of basalt and porphyritic rock. When the first example was seen, the writer was strongly inclined to disregard it, and consider it to be fortuitous, but further search revealed others, and latterly a workshop for their manufacture was found at Anna Bay. Choppers of the same calibre, but in chert, had already been discovered in the Newcastle district by the late Mr. D. F. Cooksey.[2] These porphyritic and basalt choppers have already been described by the writer.[3] We now find that similar implements occur both north and south from Morna Point. The massive basalt implement, illustrated on Pl. xxvii, fig. 5, together with another (Plate xxvii, fig. 9) were dug up by Mr. Rex Burns, in rock shelters on Mangrove Mountain. These two specimens have been kindly lent by the owner. The larger (Plate xxvii, fig. 5) is ovoid in outline, with a long cutting-edge; thickest in the dorsal region and should have been a very serviceable implement. The figured side shows very few facets, but the reverse is chipped laterally to extend the blade. An experiment was made with one of these choppers on a log of wood. The result was surprising. The weight of the implement combined with the comparatively sharp cutting-edge caused the chips to fly quite readily. It was suggested by Mr. J. S. Falkinder, of Tasmania, that these choppers were used in tree climbing, but they are just as useful for chopping wood lying in a horizontal position.

The other chopper from Mangrove Mountain is more wedge-shaped (Plate xxvii, fig. 9). The blade forms an ideal V-shaped edge; the dorsal area has been flaked to accommodate the hand, while one end has a bull-nose curve which admirably

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[2] Thorpe.—Rec. Austr. Mus., xvi, No. 5, 1928, p. 245, pl. xx, fig. 1.

[3] *Loc. cit.*, p. 245, pl. xx, xxi and xxii, figs. 1 and 2.

serves as a rest for the forefinger. This specimen has much in common with a chopper from Morna Point already figured.[4]

For comparison, opportunity is now taken to include six other choppers from Anna Bay and Port Stephens district, New South Wales, all collected for the Museum by the writer. Plate xxviii, fig. 3, is a rather good example from One-mile Beach, Anna Bay. It is of red porphyry, well-shaped, with curved back and retouched cutting-edge.

Plate xxviii, fig. 5, of grey porphyry, was unearthed in a shell midden at "The Gibbers", Tilligery Creek, Port Stephens, during December, 1929. It compares very closely with the preceding specimen.

Plate xxviii, fig. 2, is a compact little chopper, characters in common with one already figured.[5] It is considerably patinated and sandworn. The cutting-edge is definite, one side of the blade following a cleavage line in the stone. The dorsal region is well rounded and adaptable to the hand. Found on a midden at Dark Point, north of Port Stephens.

Plate xxviii, fig. 4, is more rounded than is usual and not so carefully made. The cutting-edge is rugged, but serviceable. The thickest portion of the implement lies across the dorsal area. From a midden at Dark Point, north of Port Stephens.

The last of the series (Plate xxviii, fig. 1) consists of a very massive hand implement composed of grey porphyritic rock, probably acquired by the fire-cracking progress. The unfigured side is flattened. The obverse and dorsal aspect show the weathered margin of the mass when *in situ*. The blade is flaked with a definite bevel, and the cutting-edge serrated by chipping. The greatest thickness lies across the flat dorsal region. By reason of the care taken in the production of the blade, it should have been a very effective chopper. Dark Point, north of Port Stephens. Australian Museum collections, Reg. No. E.32371.

Stone Axes.

Many stone axes have been unearthed in the rock shelters on Mangrove Mountain. Found under similar circumstances, and often in the same shelter as the basalt pounders, these implements show considerable age. They also lack the usual finish one would expect in these cutting tools. All three figured examples (Plate xxix, figs. 1-2, and Plate xxvii, fig. 6) are made of basalt, with the cutting-edges definite, but obtuse. The larger (Plate xxix, fig. 2) is irregular in form, but bears the best blade. The other two are more stocky, asymmetrical, and possessing little character. Probably having been made hundreds of years ago, and although lying below the surface in a fairly dry situation, they have undergone extensive weathering. The surfaces are pitted, and when discovered were coated with a reddish powder. The dimensions and weights are given elsewhere. Presented by Mr. Roy Mackenzie, 1930.

Another specimen (Plate xxviii, fig. 6) prepared by flaking only, from a shelter in the same district, is of a well-known type. The oxidation still adheres, and it possesses a flaked working edge. It is almost identical with the flaked

[4] Thorpe.—Rec. Austr. Mus., xvi, No. 5, 1928, pl. xx, fig. 3.

[5] Thorpe.—Rec. Austr. Mus., xvi, No. 5, 1928, pl. xx, fig. 3.

implements found in the Nepean valley.[6] The same remarks as to age similarly apply. Presented by Mr. Rex Burns, 1930.

Whilst this paper was in preparation, several other axes and stone implements were brought under the writer's notice. Mr. Robert Turner, F.R.A.I., submitted four. Though not unique in character, it was thought advisable to include a description of them. Plate xxix, fig. 4, is a massive asymmetrical implement with a well-defined blade. It has been made from a large natural pebble laterally trimmed. The aboriginal axe has a large range in size. This is one of the heavier type, but its weight and dimensions have often been exceeded.

In common with other parts of this State, the natives of the Sydney district used ground axes. Very few of these have been preserved. This circumstance makes those about to be described of more than passing interest. Plate xxix, fig. 5, is one of normal type provided with lateral depressions and evidence of use as a pounder on the butt end. These hollows have been called "thumb and finger holds", but their special purpose is a matter of conjecture. The claim just made is applicable to some examples, by reason of the position of the depressions, but where they are so close to the blade as in this example, it is practically impossible to hold the implement in this way and use it effectively. The depressions also are not always in apposition, or well defined on one side and not the other. Another suggestion is that they served as "husking holes", but even this use would not invariably apply. This axe was found in the vicinity of the public baths at the Spit, Middle Harbour, a locality known in the aboriginal vernacular as Burrabri.

Plate xxix, fig. 7, is of a different type. It has been partly flaked down to its present dimensions, and the blade is angular to the sides. This is the first known example from Mona Vale, a coastal locality about twelve miles north of Port Jackson. The only noteworthy feature is its almost straight and well-defined blade.

Plate xxix, fig. 8, is a very elementary form; in fact no more than a sharpened water-worn pebble. It also shows slight use as a hammer. On account of it being found in a metropolitan locality it is included. Quibray is an extensive midden not far from the southern shores of Botany Bay, and was, at one time, a large camping-ground of the aborigines.

The opportunity is also taken of describing three axes from the cabinets of Mr. K. M. Cobb. Plate xxx, fig. 1, is another of the massive type, well made by the "pecking process", with slight notches on the lateral margins, showing that hafting was intended. The blade is rounded and tapering, the implement being comparable with the massive forms described by Roth.[7]

Many grooved axes have been found in eastern Australia. The home of the culture seems to have been in the western districts of New South Wales, notably in the region of the Darling River. Such axes occur in Victoria and Queensland. One example was found on the coast at Cape Hawke. Their parallel similitude with the American grooved axe[8] has been frequently noticed. Doubly-grooved types are uncommon; Plate xxxi, fig. 5, is of this type. The grooves do not entirely

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[6] Thorpe.—REC. AUSTR. MUS., xviii, No. 3, 1931, pl. x, fig. 15.

[7] Roth, W.E.—North Queensland Ethnography, Bulletin No. 7, Brisbane, 1904, pl. xi, fig. 69.

[8] "Handbook of American Indians", Bureau of American Ethnology, Bulletin 30, Part 1, 1907, p. 121.

encircle the implement, but they are well defined. The grooves and reduction of the blade have been attained by pecking, which necessitated very little subsequent grinding. Plate xxix, fig. 6, is a very primitive attempt to fashion a flaked axe. It has a resemblance to implements discovered by Seton-Karr in the laterite deposits of Madras. Both sides are coarsely flaked, and a trimmed cutting-edge makes one conclude that it was used in this condition and not ground.

Other axes include a very large basaltic example (Plate xxx, figs. 3–4) discovered by a workman when digging a post hole at Homebush Bay, Port Jackson, in 1927. It could be more correctly termed a "wedge", its weight precluding its use as a normal axe. In outline it is perfect and probably the largest of the lenticular form extant. It is the property of Mr. M. S. Stanley, who loaned it to the Museum for description and reproduction (Cast, L.1682).

Another symmetrical axe (Plate xxxi, fig. 1) comes from Sylvania, George's River, New South Wales. Also composed of basaltic rock and much weathered. It was unearthed by Mr. T. Renouf, and presented to the Trustees of this Museum. Its undoubted antiquity and almost perfect outline are the main characteristics of this surface-pitted specimen.

While on the collecting trip to Mangrove Mountain, west of Gosford, New South Wales, the writer was shown this interesting relic of the Brisbane Water tribes (Plate xxxi, fig. 3). It is one of the very few hafted axes remaining which had their origin in this State. It was found in a rock crevice by Mr. J. White, a local resident, who kindly loaned it for description and temporary deposit in the Australian Museum. It had evidently laid in the crevice since it was placed there by its native owner. The blade is of basalt, the encircling handle being of a split sapling made flexible by steaming while green. Bush resin, locally known as "tuggerah", and bark caulking have been added to keep it in position. Two ties of native cordage, absent when the axe was discovered, have been added to give stability to the implement. The area for this lashing was indicated by being bleached, following on the rotting of the original binding.

Two exceptional examples of aboriginal flakework are shown in Plate xxxi, figs. 4 and 7. These are laboriously flaked on both sides and trimmed on the periphery. Found at Tamworth, New South Wales, by Mr. M. Purcell, it was at first thought that they were finished implements, but a search through the Museum cabinets proved that there were three others (E.9461, E.12677–8), from the same area, fashioned in the same way, but completed with *ground* blades.

An unusual dual purpose implement is shown in Plate xxxi, fig. 2—an axe and chopper combined. Ploughed up near Penrith, New South Wales, by Mr. L. H. Preston, it has a definite ground blade and a serviceable flaked side. This is not a unique specimen, there being another (E.31532) from a neighbouring locality in the Museum collections.

Grooved Implements.

Massive grooved implements, other than axes, more or less cylindrical, have been found from time to time. In 1928 the writer described one of these with a double groove.[*] Since that time he has viewed several cylindrical forms in the collection of the late Edmund Milne, now deposited at Canberra, Federal Capital

[*] Thorpe.—Rec. Austr. Mus., xvi, No. 5, p. 248, pl. xxvii, fig. 2.

Territory, and the Australian Museum Trustees have acquired two others, one of which is now described. On account of being pointed at one end, they have been referred to as "pikes", but this name does not suit the present specimen (Plate xxix, fig. 3). It is roughly fashioned from a flattish mass of stone, the reduction being done by pecking. A shallow groove encircles it medially, and it is provided with a bevelled and flaked working edge. Crude though it is, much labour has been expended on this implement. Found at Oberon, New South Wales, and acquired by exchange. Reg. No. E.34143.

Improvised Pebble-Axes.

Last year the writer described a series of improvised pebble-axes,[10] stating that these were "in the line of the development of the normal ground axe". Since the above was published the specimen figured on Plate xxvii, fig. 2, has come to hand. It was one of a series of axes from Shellharbour, New South Wales, presented to the Museum by Mr. George McAndrew. It definitely proves the correctness of the above statement by being firstly an improvised pebble-axe, with subsequent grinding of the blade. The plain pebble under-surface of the blade has also been slightly ground.

The range of the improvised pebble-axe[11] has been extended from the coast of New South Wales to Oberon, a locality west of the Blue Mountains, by the discovery of the specimen figured on Plate xxvii, fig. 4. This interesting addition was obtained by Mr. James Whiteley, of that district.

Reverting once more to the improvised pebble-axe of our coasts,[12] the writer desires to call attention to a very massive example recently discovered at Bellambi (Plate xxx, fig. 2). By reference to the tabulated list of specimens herein described, it will at once be apparent that it exceeds in weight any former specimen.[13]. In Tasmania, these heavier types also occur. In common with those of ordinary size, it is flaked on one side only. Much labour has been expended in fashioning this implement, especially on the right flank, which could serve as an additional cutting-edge. Another large flaked implement, also from Bellambi, for which the use can only be conjectured is shown in Plate xxxi, fig. 6. The underside is naturally undulating, while the side shown in the figure is definitely convex. Four large flakes have been removed, leaving two projections. The surface is quite vitreous, probably due to the passage of sand over a very considerable period. Reg. No. E.34590.

Stone Files, Used in the Manufacture of Shell Fish-Hooks.

In 1889 the late Director of the Australian Museum (Mr. R. Etheridge), then of the Geological Survey of New South Wales, described a flat, pyriform, stone object,[14] which he discovered in association with an aboriginal interment at North Harbour, Port Jackson. He wrote: "Another implement [of Hawkesbury sandstone] oval pointed in shape, and perhaps used for piercing, or it may be

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[10] Thorpe.—Rec. Austr. Mus., xviii, No. 3, pp. 92-95, pls. ix-x.

[11] *Loc. cit.*, p. 92.

[12] Thorpe.—Rec. Austr. Mus., xviii, No. 3, 1931, pp. 92-95, pls. ix and x.

[13] *Cf. loc. cit.*, pl. ix, fig. 5 (3 lb. 4 oz.).

[14] Etheridge.—Records of the Geological Survey of New South Wales, i, Part 2, 1889, p. 144, pl. xx, fig. 3.

even used as an ornament. Similar implements to this have been obtained by Dr. E. P. Ramsay, from aboriginal interments, in eastern Australia, but he is unable to suggest their use." Etheridge's specimen is in the Museum collection, registered No. E.12768.

In 1896 the late Charles Hedley unearthed a similar object (Australian Museum, registered No. E.5500) in a rock-shelter at Parsley Bay, Port Jackson. This was tentatively called a "spear-head". While digging out a shelter at Como, George's River, in 1905, the writer found still another of these puzzling objects (E. 22918). A similar experience was repeated at Woollahra Point, Port Jackson, in 1911 (E.19410). During 1928, further specimens were found on the coastal middens at Corrimal and Port Kembla, New South Wales (E.31967 and E.32012).

About two years ago, Mr. W. J. Enright, B.A., of West Maitland, New South Wales, informed the writer that, according to an old black, these objects were used for "sharpening shell fish hooks". This gave a decided impetus to the search for them. Their significance was explained to many collectors, and up till the present time of writing they have been discovered over a range exceeding three hundred miles of coast line, namely, from Port Stephens to Bermagui, New South Wales. Other localities within the limits named include Morna Point, Norah Head, Palm Beach, Port Jackson (in rock-shelters), Quibray, North Cronulla, Bellambi, Corrimal, Port Kembla, Lake Illawarra (north and south of the entrance), Shellharbour, Lake Burrill (in rock-shelter), Murramurang, near Bateman's Bay, Tuross Head and Tilba Lake Beach. No doubt they extend further, especially to the north, until the coral region is reached (see below).

It was then decided to write a description of a series of these objects. Members of the Anthropological Society of New South Wales kindly placed at my disposal about fifty specimens. Finally eighteen were selected as being typical of form and material (Plate xxxxii).

Referring once more to Mr. Enright for written detail, on August 1st, 1931, he communicated as follows: "I do not remember the name my aboriginal informant gave me for the implement you mentioned, but I am endeavouring to find out for you. The information as to the use of this implement came from the head man named 'Tony', who was king of the Kutthung (Port Stephens district). He was a full-blood, and when he gave me the information thirty-two years ago, he was a very old man. He informed me that the implement was used for sharpening shell fish hooks, and I think, from its shape, it would also be used to fashion out the shell fish hooks. I cannot think of any implement they made being applicable for such a purpose."

This *mode d'emploi* is confirmed by Dr. W. E. Roth, who described shell hooks made with *coral* files,[15] at Cape Grafton, Queensland, in 1898 as follows: "Picking a fresh 'pearl' shell (*Perna Cumingii* Reeve), the operator chipped round and round the valve between two stones, until he at last succeeded in breaking it down to a more or less circular plate about 2 inches in diameter, with rough uneven edges. He next placed two pointed pieces of hardwood on the fire, and as soon as their sharpened ends were burnt and charred, put the smouldering extremities close to the centre of this shell-plate . . . and blowing upon them with no incon-

[15] Roth, W. E.—North Queensland Ethnography, Bulletin No. 7, Brisbane, 1904, Section 68, p. 33, figs. 259*a* to 259*f*.

siderable force, caused the flame to play only upon its very centre, which was thus rendered comparatively brittle. But little difficulty was then experienced in breaking through, at this spot, with a pencil of white coral. The hole, once made, became gradually enlarged into the required oval . . . by filing backwards and forwards with the coral, which at very frequent intervals was dipped into water to assist in the grinding. The uneven outer edge of the oval ring so produced was next gradually ground into shape . . . until the desired width of hook was reached. The final processes consisted in very carefully grinding its middle up and down on a sharp vertical edge of rock until a break was obtained, and then finishing off with the rock and coral file into the completed crescentic form . . . . On the Lower Tully River, the hook is similarly manufactured from the *Perna*, the only difference being that no fire is used, the boring of the ring with the coral pencil being commenced very gently and carefully. . . . The following are extracts from Cook's Voyages concerning fish-hooks on the Endeavour River, where such articles are now unknown: '. . . Their fish-hooks are very neatly made, and some of them are exceedingly small' . . . 'bags containing some fish-hooks and lines, a shell or two, out of which hooks are made' . . . and, in reference to their few tools, mention is made of 'some shells and fragments of coral'."

In 1908, Banfield wrote:[16] "The method of manufacture was to reduce by chipping with a sharp-edged piece of quartz a portion of a black-lip mother-of-pearl shell to a disc. A central hole was then chipped—not bored or drilled—with another tool of quartz. . . . Then a segment was cut away, leaving a rough crescent, which was ground down with coral files, and the ends sharpened by rubbing on smooth slate."

We will now consider the forms, size and materials of the stone files found on the coast of New South Wales. Some are cylindro-conical (Plate xxxii, figs. 2 and 5), but more often triangular (Plate xxxii, figs. 15, 17–18), tapering and flat (Plate xxxii, figs. 1, 3, 8, 11–12, 14). In length they vary from four and a half to eleven and a half centimetres. The dimensions of these implements obviously vary according to their degree of use. The material used is white sandstone (Plate xxxii, figs. 6–9), ferruginous sandstone (Plate xxxii, figs. 10–13 and 15–18), phyllite (Plate xxxii, fig. 3) and micaceous sandstone.

For the opportunity of examining such a large series, the writer is indebted to Messrs. M. S. Stanley, R. Turner and J. S. Rolfe; and to Mr. T. Hodge-Smith and his assistant, Mr. R. O. Chalmers, for the tentative identifications of the stones used in the implements described in this contribution. In some cases the size of the specimens figured on Plates xxvii–xxxi is not relative.

EXPLANATION OF PLATES.

PLATE XXVII.

Fig. 1.—Hammer, basalt. 2 lb. 15½ × 10 × 3½ cm. Mangrove Mountain, near Gosford, New South Wales. E.33480.

Fig. 2.—Improvised axe, with subsequential grinding. 1 lb. 1 oz. 13½ × 7¼ × 3⅝ cm. Barrack Head, Shellharbour, New South Wales. E.34266.

Fig. 3.—Hammer, basalt. 1⅝ lb. 15½ × 10 × 3½ cm. Mangrove Mountain, near Gosford, New South Wales. E.33479.

Fig. 4.—Improvised axe, indurated sandstone. 1 lb. 12¼ × 8¼ × 3½ cm. Oberon, New South Wales. E.34147.

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[16] Banfield, E. J.—"Confessions of a Beachcomber," London, 1908, p. 267.

Fig. 5.—Chopper, basalt. 3 lb. 4 oz. 17 × 12¾ × 5⅝ cm. Mangrove Mountain, near Gosford, New South Wales. Lent by Mr. Rex Burns. Negative number, 5899.

Fig. 6.—Axe, basalt. 10 oz. 10½ × 5¼ × 3⅝ lb. Mangrove Mountain, near Gosford, New South Wales. E.33675.

Fig. 7.—Hammer, basalt. 1½ lb. 11¼ × 8½ × 4½ cm. Mangrove Mountain, near Gosford, New South Wales. E.33655.

Fig. 8.—Hammer, with binding, basalt. ½ lb. 8½ × 7½ × 2 cm. Mangrove Mountain, near Gosford, New South Wales. E.33481.

Fig. 9.—Chopper, basalt. 2 lb. 5 oz. 14½ × 8½ × 6 cm. (dorsal). Mangrove Mountain, near Gosford, New South Wales. Lent by Mr. Rex Burns. Negative number, 5900.

Plate XXVIII.

Fig. 1.—Massive flaked chopper, porphyritic rock. 4¼ lb. 17 × 15 × 5½ cm. Dark Point, near Port Stephens, New South Wales. E.32371.

Fig. 2.—Chopper. 1 lb. 10½ oz. 11½ × 9 × 6¼ cm. Dark Point, near Port Stephens, New South Wales. E.32372.

Fig. 3.—Chopper, porphyry. 1 lb. 6½ oz. 14½ × 7⅝ × 5¼ cm. One-mile Beach, Anna Bay, near Port Stephens, New South Wales. E.34329.

Fig. 4.—Chopper, silicified rock. 1 lb. 9 oz. 12 × 11 × 4⅝ cm. Dark Point, near Port Stephens, New South Wales. E.32115.

Fig. 5.—Chopper, porphyry. 1 lb. 8 oz. 14 × 7½ × 6⅝ cm. The Gibbers, Tilligery Creek, Port Stephens, New South Wales. E.32138.

Fig. 6.—Flaked axe, basalt. 1⅝ lb. 18 × 8⅝ × 3½ cm. Mangrove Mountain, near Gosford, New South Wales. E.33648.

Plate XXIX.

Fig. 1.—Axe, basalt. 11 oz. 10¼ × 6½ × 4 cm. Mangrove Mountain, near Gosford, New South Wales. E.33472.

Fig. 2.—Axe, basalt. 1¼ lb. 13¼ × 8½ × 3⅝ cm. Mangrove Mountain, near Gosford, New South Wales. E.33471.

Fig. 3.—Grooved implement, igneous rock (?). 4 lb. 10 oz. 23 × 9 × 7¼ cm. Oberon, New South Wales. E.34143.

Fig. 4.—Ground axe, siliceous tuff. 3⅞ lb. 17¼ × 11¼ × 6¼ cm. Seven Mile Beach, south of Port Kembla, New South Wales. Lent by Mr. R. Turner. Negative number, 5972.

Fig. 5.—Ground axe, quartzite. 1⅝ lb. 13 × 9½ × 4½ cm. The Spit, Middle Harbour, Port Jackson, New South Wales. Lent by Mr. R. Turner. Negative number, 5972.

Fig. 6.—Flaked axe or chopper, quartzite. 1 lb. 11½ × 8⅝ × 4¼ cm. Lake Peery, Paroo River. Lent by Mr. K. M. Cobb. Negative number, 5901.

Fig. 7.—Ground axe, quartzite. 1¼ lb. 11½ × 6⅝ × 4½ cm. Mona Vale, near Manly, New South Wales. Lent by Mr. R. Turner. Negative number, 5972.

Fig. 8.—Ground axe, indurated sandstone. 7 oz. 10⅝ × 6 × 2 cm. Quibray, Botany Bay, New South Wales. Lent by Mr. R. Turner. Negative number, 5972.

Plate XXX.

Fig. 1.—Massive axe, or wedge, dolerite. 4¼ lb. 18 × 14 × 5 cm. Cunnamulla, Queensland. Lent by Mr. K. M. Cobb. Negative number, 5899.

Fig. 2.—Improvised pebble axe. 4 lb. 6 oz. 21 × 12½ × 6½ cm. Bellambi, New South Wales. E.34589.

Figs. 3-4.—Massive axe, or wedge, basaltic rock. 7 lb. 12 oz. 11 × 5⅝ × 2 in. Homebush Bay, Port Jackson, New South Wales. Lent by Mr. M. S. Stanley. Negative numbers, 5418-19.

Plate XXXI.

Fig. 1.—Axe, basalt. 2 lb. 6 oz. 18 × 7⅝ × 4½ cm. Sylvania, Botany Bay, New South Wales. E.33490.

Fig. 2.—Axe and chopper combined, basalt. 1¼ lb. 15¼ × 9¼ × 2⅝ cm. Kingswood, New South Wales. E.34151.

Fig. 3.—Hafted axe, basalt. 2⅝ lb. Blade, 16½ × 11½ × 4 cm.; overall, 34 cm. Mangrove Mountain, near Gosford, New South Wales. Lent by Mr. J. White. Negative number, 5809.

Fig. 4.—Flaked axe, incomplete, indurated clay shale. ¾ lb. 10 × 8¾ × 3 cm. Tamworth district, New South Wales. E.33441.

Fig. 5.—Doubly grooved axe, quartzite. 2¼ lb. 15 × 10½ × 5 cm. Mena Murtee, Wilcannia, New South Wales. Lent by Mr. K. M. Cobb. Negative number, 5901.

Fig. 6.—Pebble chopper, basalt. 4 lb. 7 oz. 17¼ × 15½ × 6¼ cm. Bellambi, New South Wales. E.34590.

Fig. 7.—Flaked axe, incomplete, chert. 11 oz. 9¾ × 7½ × 3¾ cm. Tamworth district, New South Wales. E.33442.

Plate XXXII.

Fig. 1.—Fish hook file, grey sandstone. 1½ oz. 11 cm. Windang, Lake Illawarra, New South Wales, E.34883.

Fig. 2.—Fish hook file, schistose rock. 2 oz. 8¾ cm. Murramurang, New South Wales. E.34884.

Fig. 3.—Fish hook file, phyllite. 1¼ oz. 11½ cm. Murramurang, New South Wales. M. S. Stanley collection.

Fig. 4.—Fish hook file, schistose rock. 1 oz. 8 cm. Lake Illawarra, New South Wales. M. S. Stanley collection.

Fig. 5.—Fish hook file, fine-grained sandstone. 2½ oz. 11½ cm. Bellambi, New South Wales. E.34885.

Fig. 6.—Fish hook file, clouded sandstone. ¾ oz. 7 cm. Windang, Lake Illawarra, New South Wales. R. Turner.

Fig. 7.—Fish hook file, banded sandstone. ½ oz. 7 cm. Palm Beach, Broken Bay, New South Wales. E.34886.

Fig. 8.—Fish hook file, white sandstone. 1½ oz. 9½ cm. Quibray, Botany Bay, New South Wales. E.34887.

Fig. 9.—Fish hook file, white sandstone. 1 oz. 6¾ cm. North Cronulla, New South Wales. E.34889.

Fig. 10.—Fish hook file, ferruginous sandstone. ¼ oz. 5½ cm. Windang, Lake Illawarra, New South Wales. R. Turner.

Fig. 11.—Fish hook file, ferruginous sandstone. ⅝ oz. 7¼ cm Quibray, Botany Bay, New South Wales. J. S. Rolfe.

Fig. 12.—Fish hook file, ferruginous sandstone. ¼ oz. 6½ cm. Palm Beach, Broken Bay, New South Wales. R. Turner.

Fig. 13.—Fish hook file, ferruginous sandstone. ⅝ oz. 8 cm. Quibray, Botany Bay, New South Wales. R. Turner.

Fig. 14.—Fish hook file, micaceous sandstone. 1¾ oz. 9 cm Murramurang, New South Wales. M. S. Stanley.

Fig. 15.—Fish hook file, sandstone, with ferruginous coating. ¾ oz 7½ cm. Quibray, Botany Bay, New South Wales. J. S. Rolfe.

Fig. 16.—Fish hook file, ferruginous sandstone. 1 oz. 6¾ cm North Cronulla, New South Wales. E.34890.

Fig. 17.—Fish hook file, ferruginous sandstone. ¾ oz. 7 cm. Quibray, Botany Bay, New South Wales. E.34888.

Fig. 18.—Fish hook file, ferruginous sandstone. ¾ oz. 8 cm Quibray, Botany Bay, New South Wales. J. S. Rolfe.

THE WEEKEROO METEORITE: A SIDERITE FROM SOUTH AUSTRALIA.

By

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(Plate xxxiii.)

This siderite was found in 1924 by Mr. James Lane at Weekeroo Station, Mannahill, South Australia (Lat. 32° 16′ S., Long. 139° 52′ E.). According to Mr. Lane, it was found "on the brow of a big hill resting on a quartz reef level with the surface."

It was a complete iron weighing 94·2 kg. (207½ lb.), of which the main mass, weighing 47 kg., is in the collection of the Australian Museum. It measured approximately 50 cm. by 27 cm. by 19 cm.

The external appearance is typical of a siderite, the characteristic "thumb-marks" being present. The iron was cut into two portions along the major axis. Considerable difficulty was experienced in completing this work, which was carried out by the New South Wales Government Railway Workshops at Eveleigh. This difficulty was the first indication that the siderite was of an unusual type, the cause of the trouble being the presence of numerous nodules of silicate minerals and troilite. The cut surface of the mass retained by the Museum was polished and etched with weak nitric acid, the section so obtained measuring 49 cm. by 19 cm., and containing 324 inclusions of troilite and silicate minerals.

A Rosiwal analysis carried out on this section gave as a result 96·23 per cent. of nickel-iron, 3 per cent. of troilite, and 0·77 per cent. of silicate minerals. This analysis showed also that the inclusions were fairly evenly distributed, being slightly more numerous in the centre portion than at either end. The results are as follows:

End portion	3·48 per cent. of inclusions
Centre portion	4·71 per cent. of inclusions
End portion	3·46 per cent. of inclusions
Whole section	3·77 per cent. of inclusions

The result of the etching revealed the fact that the iron is unique among recorded Australian falls. The surface contains numerous cracks which surround portions differently orientated, giving the iron a brecciated appearance. The iron in the different portions belongs to the broad octahedrite type. The troilite and silicate inclusions are mostly found along the cracks. The iron is therefore a brecciated octahedrite with silicate grains, and appears to belong to the Copiapo group (Obc) of the Brezina classification.[1] Brezina includes only one iron, the

[1] Brezina.—Annalen. des K.K. naturhist. Hofmuseums, x, 1895, pp. 232-307.

Copiapo, in this group. From the description and figure given by Haidinger[3] it would appear that the Weekeroo siderite closely resembles this iron.

For the purpose of analysis, thirty grammes of material were used, and the following results were obtained:

Fe	91·40
Ni	6·89
Co	0·46
S	1·02
P	Trace
C	0·01
Silicates	0·79
	100·57

The following is the mineral constitution of the iron calculated from the above analysis:

Nickel-iron	96·96
Troilite	2·81
Schreibersite	Trace
Carbon	0·01
Silicates	0·79
	100·57

The nickel-iron ratio is 12·2.

The residue left after solution with concentrated hydrochloric acid was examined under the microscope, and only one silicate mineral appeared to be present. It was found to vary in colour from pale green to white. The largest fragment obtained in this way was about 3 mm. in diameter, and, like the other fragments, very easily broke up into minute acicular crystals, which were arranged radially in the fragment; the lustre is pearly to vitreous and optically the mineral agreed with enstatite. Any olivine present would have been decomposed by the action of the acid, but the absence of silica both in the solution and the residue indicates that olivine was absent.

The carbon content was estimated by heating the insoluble in oxygen and estimating carbon from the CO_2 liberated in the usual way. The carbon is most probably in the form of graphite, of which extremely small black specks were seen under the microscope. A very little black material, which was soluble in aqua regia, was left after ignition. This material belonged to the platinum group of metals, but was much too small for exact determination.

EXPLANATION OF PLATE XXXIII.

Figs. 1-2.—Two views of the Weekeroo Meteorite before cutting.

Fig. 3.—Etched surface of the main mass of the Weekeroo Meteorite, showing nodules of troilite and silicate minerals. The brecciated nature of the iron is shown in the numerous cracks.

[3] Haidinger.—Sitzung Akad. Wiss. Wien. Math. naturwiss K., xlix, 1864, p. 490.

A NEW GENUS AND SPECIES OF SEA-SLUG, AND TWO NEW SPECIES OF SEA-HARES FROM AUSTRALIA.

By

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(Plates xxxiv-xxxv.)

During the last two years I have been able, through the kindness of the Director of the Taronga Zoological Park and the help of the staff of the Zoo Aquarium, to study and make observations upon Mollusca, particularly sea-slugs and sea-hares, living there in captivity. This has helped me considerably in identifying or describing material, as the animals of both these groups mentioned are liable to undergo a severe change in colour and form in preservative, and unless some record of these characters is made when the animals are alive, later research work on them may prove very difficult.

My thanks are, therefore, due to those who have helped me in this way, and I hope as a result of the opportunities afforded me, and with the aid of the material in the Australian Museum collection, to publish papers dealing with these two groups, so common in Australia yet so much neglected, the sea-slugs and the sea-hares.

Family FIMBRIIDÆ.

Genus **Propemelibe**, gen. nov.

Orthotype, **Propemelibe mirifica**, sp. nov.

Animal very large and showy, gelatinous, elliptical in shape, with a constricted neck and the head enlarged into an enormous rounded fringed veil with thickened edges. This veil is about half the size of the main part of the body. Rhinophores about half-way down the veil, set fairly well apart and retractile into truncate sheaths with minute stalks. Dorsal surface of the animal covered with irregular sized pustules and branched filaments, including the cerata. Cerata arranged in a single row along each side, very large when fully grown, about 5-7 along each side.

Foot very broad, mouth at the base of the veil, with thickened lips, no radula, but minute jaws. A dark belt of horny processes lines the lower portion of the posterior part of the stomach. Liver divided, extending to the cerata.

I have been compelled to create this new genus for the very interesting and hitherto unrecorded species described below, because of the difficulty experienced in placing it definitely in either of the two genera it resembles. Externally it resembles the genus *Fimbria* Bohadsch, 1761,[1] but, on the other hand, it has several internal characters of the genus *Melibe* Rang, 1829.[2]

[1] Bohadsch.—Animalibus Marinis, 1761, pp. 54-64, pl. v, figs. 1-3; O'Donoghue, Trans. Zool. Soc., xxii, 6, 1929, p. 715.

[2] Rang.—Manuel de l'Histoire Naturelle des Mollusques, 1829, p. 129, pl. iii, fig. b.

In *Fimbria fimbria* (Linné), the type of *Fimbria*, from the Mediterranean, the veil is large, the tentacles are not on long stalks, the foot is broad and the body is plump and elliptical and not elongated into a tail. The tufts and cerata are very small, the latter not so well defined as those of *Melibe*. In *Melibe rosea* Rang, the type of *Melibe*, from the Cape of Good Hope, the body is thin and elongated into a long tail, the foot is extremely narrow with a deep furrow along it, the veil is much smaller than that of *Fimbria*, being only about one-seventh the length of the body, and the tentacles are on long slender stalks. The presence of jaws, though minute, and the belt of horny processes lining the posterior portion of the stomach of *Melibe* are, according to most authors, the main differences between *Melibe* and *Fimbria*.

My species has the elliptic body, broad foot, and extremely large veil of *Fimbria*, but the small jaws and the belt of processes in the stomach of *Melibe*. I, therefore, propose the new generic name *Propemelibe* for this species, the only other specimen of which, to my knowledge, is in the Queensland Museum collection. Through the kindness of the Director of the Institution, Mr. H. A. Longman, I was able to examine it, and found it identical with mine, though it would probably have been a little larger in life. It was labelled M.O. 1297, *Tethys leporina*, Moreton Bay, Queensland, a name, I believe, suggested for it by Mr. T. Iredale when shown it while on a visit to the Queensland Museum. It was quite unknown there.

Propemelibe mirifica, sp. nov.

(Plate xxxiv, figs. 1-8.)

Animal very large, over a foot in length, gelatinous and fairly transparent, conspicuous. Foot very broad and solid, wider at the anterior end, rounded at the posterior end. A short neck joins the body to the head, which is extended into an enormous circular membranous mantle or veil, about 7-8 inches in diameter, as long as the foot and about half the size of the animal. When expanded the veil looks like a large jelly-fish. Round its thickened edges are about four rows of numerous irregular-sized cilia, the largest ½ inch long. The rows are interrupted for about two inches at the central posterior, and central anterior portion of the margins. Within the veil at the posterior end is a large rounded mouth with thick fleshy lips. The rhinophores are slender and retractile into large receptacles broad at their tops and slender at the base, situated about half-way along the dorsal surface of the veil and fairly far apart. Along each side of the dorsal surface are arranged from five to seven variously sized and bluntly shaped cerata with broad bases and their upper margins divided into mostly three lobes. One particular one, at the posterior end of the animal, was particularly large and striking, and was about four inches high and stood well up beyond the back of the animal. It was constantly in movement and was one of the first to be cast off. When removed from the water after being cast off, it gave out a sickly sweet smell, showed signs of life for several days, and when touched would curl up its edges and exhibit general movement. The remaining cerata, ranging from half inch to two inches in size, grew rapidly. They were colourless, except for minute speckling, and by the time the animal died had all been cast off.

The whole dorsal surface of the animal is covered with large and small blister-like pustules, which are capable of contracting and expanding. Along

the central back is a dense mass of fluffy branched filaments reaching from almost the tail-tip to about half-way along the centre of the veil, and in company with the pustules and cerata, these are constantly in movement.

On dissecting the animal, no radula was found, but a pair of small pale coloured jaws, 6 mm. in length, were found imbedded below the lips. They are almost membranous, thickened at their point of junction, with edges not denticulated, but faintly striated and undulated. The entrance to the stomach was blocked by stringy weed. The stomach has a small upper part divided from a larger lower part by a slight constriction. In the posterior portion of this lower area is a large belt of very conspicuous, dark greeny-brown, white-tipped, lancet-shaped plates, small ones of varying size intermingling with the large ones. There are about 40 of these plates and the largest is 8 mm. in length. The liver is divided into 5-7 masses of irregular-sized balls, rising just in advance of the horny plates on either side and extending to the cerata. The intestine is fairly short and broad, with a rather rounded portion where it meets the stomach. It turns to the right and terminates in a rosette-shaped anus on the right side of the dorsal surface of the animal. The penis is very broad, curved, and beak-shaped at the anterior end. The genital opening is about two inches above the anal opening.

The animal is transparent and gelatinous, with a beautiful pinky-blue tinge over it. The cilia round the veil are deep rose-pink, except the uppermost row, which is white. A minute speckling of rose-pink is over the animal, especially round the veil edge. Inside the veil edge is a deep border, about an inch wide, of this speckling, which shows through to the outer surface. Round the mouth opening a large patch of speckling also occurs. The pustules over the surface are rich rose-pink or white. The branched filaments along the back are a smoky-grey with a pinkish tinge. These are tipped with silvery-white. The small cerata had suggestions of pustules on them, but were practically colourless. The large one was a most vivid ornamentation to the animal. When on the animal it had a large thick rachis with the upper end expanded into a thick club-shaped structure. Gelatinous like the body, it had large fluffy white and ruby-red protuberances on it. On the upper portion of the side away from the body was a large brilliant magenta patch of colour with big white pustules on it. The branched filaments scattered over the animal were a pale brown with faint speckling on them. The foot was colourless.

Owing to preservation, much of the colour has already disappeared and the animal has considerably diminished in size.

Loc.—Off Cairns wharf, Queensland. Type, Australian Museum collection. Reg. No. C. 57494.

This very interesting and beautiful creature was captured in a bucket by the crew of the Colonial Sugar Refining Company's boat "Fiona", and brought to the aquarium at Taronga Zoo, Sydney, about 19th August, 1931. It was swimming about and no fisherman at Cairns had seen it previously.

While it was in the aquarium, where it lived for about a fortnight, observations were made upon it. When first placed there it was very active, swimming and rising to the surface constantly by somersaulting. No particular crawling powers were noticed, although it moved slightly backwards or forwards on its broad foot. At a temperature of 69° Fahr. it was very lively, but at 76° it became sluggish. Between 69°-72° suited it well. Its favourite position was resting on

the bottom of the aquarium on its broad foot with the extraordinary large veil raised. This veil expanded like a large plate and was swept over the sandy bottom with the cilia furiously moving. Material was then scooped up by folding the edges of the veil in until they came together over the mouth. When the veil was in a raised position I noticed that the action of folding and unfolding the edges together served almost as a magnet for sweeping in towards the mouth pieces of food in the water, as though a suction was set up. The weeds put in for food did not appeal to the slug, but it relished small pieces of prawn. Some fishes, *Zanclus canescens*, popularly known as Moorish Idols, placed in the same tank temporarily, ate the cilia on the veil and had to be removed.

The cerata grew rapidly, but were discarded easily. The big one, which constantly twisted and bent, came away just after the animal laid some eggs. The vivid colouring and the sickly sweet smell it gave off when removed from the water after being discarded are probably protective qualities.

The eggs were laid just at full moon, about six days after it was placed in the aquarium. The egg girdle was large and gelatinous with about sixty pale pink eggs in each capsule. These eggs gave a beautiful foamy pink appearance to the whole girdle.

A week after egg-laying the animal appeared sick, became sluggish, hid away in rock crevices, and when it did emerge suspended itself perpendicularly on its tail-tip with the veil up for long periods. Gradually the cerata were discarded, the filaments and pustules shrank, and the next day it died.

Family TETHYIDÆ.

Genus **Ramosaclesia** Iredale, 1929.

Ramosaclesia Iredale, Austr. Zool., v, 4, 23rd March, 1929, p. 352. Orthotype, *Aclesia glauca* Cheeseman, Proc Zool. Soc., Lond., 1878, p. 277, pl xv, fig. 4.

Ramosaclesia rex, sp. nov.

(Plate xxxv, figs. 1-6.)

Animal large, soft, plump and oval-shaped, with a fairly short head and stumpy tail. Two pairs of long linear tentacles are on the dorsal surface with branched filaments on them. Pleuropodial lobes small, united behind a large gill cavity. Mantle small, not covering the long curved gill. Foot very broad, terminating in the stumpy tail; squarely truncate at the anterior end, where it is laminated. Mouth large and round, sides of lips formed into two large flaps, giving the appearance of another pair of tentacles. Body covered with numerous simple or branched, almost transparent processes, the largest over an inch long. A row of the large filaments extends along each side of the central dorsal area from the tail to the head. Below this is another row of slightly smaller ones. All round and below them are numerous other branched and single processes. Round the entire edge of the foot is a thick line of the single filaments. Scattered over the surface of the animal are very small white and yellow hard pustules.

The body colour of the slug is light green with a bluish tinge towards the sides. Branched and single filaments are transparent light yellow-brown, with conspicuous black rings and dots on their bases, changing to fine black speckling on the upper part of the main stems and on the branches. Large and small

patches of black markings are over the dorsal surface. These extend into the tentacles and are dense round the head and sides.

When examined closely it is found that these black markings are formed by patches of black rings round the little hard pustules. Intermingling with them is fine black speckling, especially round the sides, round the mouth, under the labial flaps, and on the anterior and posterior portion of the foot. Standing out vividly against the green body colour of the animal is a double row on each side of the dorsal surface, about five in number, of rounded bright peacock-blue spots, with a narrow black band encircling them and a black centre spot. Gills pale colour, speckled with black. The inside of the pleuropodial lobes is pale green with scattered black spots and markings. Mantle similarly marked. Foot pale greenish colour.

Jaws easily recognized, large, broad and curved, olive-brown colour; radula dark brown, almost cordate shaped with about 30 rows of closely packed, long, slender, curved teeth with wider short bases. Some of these are plain, others have one or both edges serrated.

Eggs are laid in a dense, pale, greenish-yellow string-like mass, the string about 2 mm. wide.

Length of an average large specimen, 170 mm. extended and 61 mm. high; foot 61 mm. wide.

Loc.—Between twenty and thirty specimens were found by Master Rex Iredale in Manly Lagoon, Queenscliff, near Sydney, on the 3rd March, 1931. They were discovered just about the time of full moon, crawling on zostera weed, and several had their eggs attached. Several specimens were brought to the Museum, six of which were taken to the Taronga Park Aquarium, where they lived for some time and were under observation. Type, Australian Museum collection. Reg. No. C. 57495.

They were very lively creatures, constantly crawling about and feeding voraciously on weeds placed in the tank. They elongated considerably when crawling, but assumed a hunched up, hare-like appearance when feeding or resting. Their favourite mode of crawling is in an almost continuous line with the head of one touching the tail of the other. The crawling movement was made by gliding the undersurface of the foot; the upper portion of the body did not undulate. Whether resting or crawling, the body appendages are constantly in motion. After crawling up the sides of the tank to the surface of the water, the animals would reach the bottom again by a somersaulting movement. The pleuropodial lobes are usually only opened for excretory purposes. After being a week in captivity several laid eggs. These remained intact for about six days, but gradually faded in colour, broke into small pieces and disappeared. More eggs were laid at the next full moon, after which the slugs gradually died, the last one on the 7th April, after being a month in captivity. On 12th April five more, including a little one, were placed in the aquarium. They were buried down at a depth of about eight feet in the same locality as the previous ones and were dragged up by an oar. These were smaller in size than the others, but were just as lively. One laid a mass of sage-green eggs, and all but one small one died during the last days of April.

Between the 2nd and 3rd of May, again at the time of full moon, thirteen of these slugs were found by Master Iredale, crawling on the mud, not weed, in the

same place about three feet down. After heavy falls of rain in the lagoon, the slugs were noticed buried deep down in the water and appeared quite sick, as though the addition of fresh water affected them and caused them to submerge to escape it. The second lot placed in the aquarium lived for about a month, except one small one, which died on or about 3rd September, after having been in captivity practically five months.

Only once previous has there been any record of these sea-hares being found in eastern Australian waters. About 1895, the late Charles Hedley found several specimens of this species on the zostera flat at Rose Bay, Sydney Harbour. They were curled up, and with one exception were either dead or dying from, Hedley suspected, the volumes of fresh water which recent rains had poured into that place.

The species was referred tentatively to *Aclesia glauca* Cheeseman.[8] Hedley endeavoured to procure specimens from New Zealand, but was unsuccessful, as the species was rare there. When the specimens were found in Manly Lagoon, I enquired for New Zealand ones and received the same reply.

The Australian species seem larger, slightly differently coloured, with brighter body processes than the New Zealand ones. The spots on them are peacock-blue instead of emerald green, and the dark patches appear more numerous. Some teeth on the radula are serrated, whereas Cheeseman describes those of his species as simple, but the serrations may have been invisible.

I agree with Hedley that it is doubtful whether this, a non-swimming creature, would be the same species as the New Zealand one, and therefore propose a new specific name *rex* for the Australian one.

Genus **Tethys** Linné, 1758.

Tethys Linné, Syst. Nat. (10), 1758, p. 653. Type, *Tethys leporina* L., 1758.

Tethys extraordinaria, sp. nov.

(Plate xxxv, figs. 7-8.)

Animal very large, fleshy and active. When extended reaching almost to a foot in length. The two pleuropodial lobes are extremely large and expansive, are constantly in movement and when open expose the interior. They reach to a height of about 5½ inches from the foot edge, and are united behind, well down the tail.* These lobes are used for swimming, a performance noticed in the animal under discussion while it was in captivity. The two dorsal tentacles long and linear. Frontal lobes wide. Gill plume large. Foot broad anteriorly, narrowing posteriorly.

This extremely large species of *Tethys* is easily recognized by its conspicuous marking and unusual colour. The body colour is a rich umber-brown, with numerous large white spots and dashes over the whole dorsal surface, especially towards the lower surface near the foot edges. Broad, irregular, longitudinal, white bands, with small white spots between them, outline the edges of the pleuropodial lobes, extending downwards. Fine black veinings cover the whole surface of the animal with numbers of small black spots adjacent to or on them. Two larger black spots are situated together near the frontal lobes.

[8] Cheeseman.—Proc. Zool. Soc., 1878, p. 277, pl. xv, fig. 4.

On the inside of the pleuropodial lobes are white bands similar to those on the outside, with white mottling scattered round them. The mantle is mottled with similar white marking. The gill plume is pale, touched with dark brown.

The shell is large, thin, and depressed, 75 mm. long, 56 mm. broad.

Loc.—Sydney Harbour, New South Wales.

This remarkable species, the largest sea-hare recorded so far from New South Wales, was placed in the Aquarium at Taronga Zoological Park early in April, 1931, where it thrived well for some weeks, and during that time laid from four to five lots of large rich yellow string-like masses of eggs. Towards the end of April members of the Aquarium staff caught five more specimens in Athol Bay, Sydney Harbour, in a net 125 feet long, thrown over about 300 yards from the shore. They remarked that they were very numerous in that part of the harbour at that time.

Only one specimen, the first to be placed in the tank, was preserved, and this is now in the Australian Museum collection. Reg. No. C.57496. Recently two specimens of undoubtedly the same species as this were found swimming at Bottle and Glass Rocks, Sydney Harbour, by Mr. G. P. Whitley. They were smaller than the type specimen, and although there were no distinct white longitudinal marks on the outside of the pleuropodial lobes, there was a suggestion of them on the inside of the lobes. Otherwise the animals were similar.

EXPLANATION OF PLATES.

Plate XXXIV.

Propemelibe mirifica, gen. and sp. nov.

1. Side view with veil expanded.
2. Internal structure: b = buccal mass, n = nerve centre, p = penis, u = stomach, f = female orifice, h = belt of horny processes in stomach, i = intestines, c = pericardium, a = anus, l = liver, g = gastrohepatic apparatus.
3. Single large cerata fully developed, showing dark patch of colour.
4. Side view of cerata.
5. Jaws.
6. Belt of horny processes lining portion of stomach.
7. Side view of single process from the belt.
8. Branched filaments from the dorsal surface and cerata.

Plate XXXV.

Ramosaclesia rex, sp. nov.

1. Side view.
2. Single jaw.
3. Teeth from radula.
4. Branched and unbranched filaments from the dorsal surface.
5. Dark spot from base of filaments, much enlarged.
6. Coloured spot on the dorsal surface, enlarged.

Tethys extraordinaria sp. nov.

7. Side view.
8. Shell.

STUDIES IN ICHTHYOLOGY.

No. 6.*

By

GILBERT P. WHITLEY,
Ichthyologist, The Australian Museum, Sydney.

(Plates xxxvi-xxxix and Figures 1-3.)

Part I.—Class ELASMOBRANCHII.

Family ORECTOLOBIDÆ.

Genus **Hemiscyllium** Müller and Henle, 1838.

Hemiscyllium trispeculare Richardson.

(Plate xxxvi, fig. 2.)

Hemiscyllium trispeculare Richardson, Icones Piscium, 1843, p. 5, pl. i, fig. 2. Turtle Island, north-west Australia. Based on a drawing by Lieut. Emery. *Id.* Richardson, Zool. Voy. Erebus and Terror, Fish., March, 1845, p. 43, pl. xxviii and text-figs. 1-2. *Id.* Duméril, Hist. Nat. Poiss., i, 1, 1865, p. 326. *Id.* Günther, Ann. Mag. Nat. Hist. (3), xx, 1867, p. 67 (Turtle Is. and Cape York). Types in British Museum.

Chiloscyllium trispeculare Günther, Cat. Fish. Brit. Mus., viii, 1870, p. 411. *Id.* Regan, Proc. Zool. Soc. Lond., 1908, p. 359 (type). *Id.* Ogilby and McCulloch, Proc. Roy. Soc. N. S. Wales, xlii, 1909, p. 293. *Id.* Ogilby, Mem. Qld. Mus., iii, 1915, p. 131; *ibid.* v, 1916, pp. 77 and 93. *Id.* Paradice and Whitley, Mem. Qld. Mus., ix, 1; 1927, p. 96 (Knight Reef, Clarence Str., N. Australia).

The accompanying figure represents a specimen (Austr. Mus. Regd. No. I.5268) 540 mm. long, from Port Darwin, North Australia, collected by Messrs. Christie and Godfrey. The species has been well described and compared with *H. ocellatum* by Richardson (1845).

Range.—North and north-western Australia.

Hemiscyllium ocellatum (Bonnaterre).

(Plate xxxvi, fig. 1.)

Squalus ocellatus Bonnaterre, Tabl. Encycl. Meth. Ichth., 1788, p. 8. Based on "L'Oeillé" Broussonet, Mem. Acad. Sci. Paris, 1780, p. 660, No. 10, vernac. "côté de la nouvelle Hollande" (Banks) [= northern Queensland]. Synonyms: *Scylium ocellatus* Eichwald, 1819; *Scyliorhinus ocellatus* Blainville, 1816; *Squalus oculatus* Gray, 1826; *Hemiscyllium ocellatum* Müller and Henle, 1838; *Scyllium ocellatum* Blyth, 1847; *Hemiscyllium oculatum* Duméril, 1865.

Chiloscyllium ocellatum Günther, Cat. Fish. Brit. Mus., viii, 1870, p. 411 (refs. and synonymy), and of most later authors.

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* For No. 5, see RECORDS OF THE AUSTRALIAN MUSEUM, Vol. xviii, No. 4, 1931, p. 138.

This species has been dealt with in detail by Ogilby and McCulloch,[1] but a new figure, contrasting it with its Dampierian ally, *H. trispeculare*, is here given, prepared from a specimen (No. IA.4485), 400 mm. long, collected by the writer at Low Isles, North Queensland.

Range.—Queensland, common on the Great Barrier Reef in shallow water; New Guinea and beyond.

Genus **Chiloscyllium** Müller and Henle, 1837.

Chiloscyllium punctatum Müller and Henle.

(Text-fig. 1.)

Chiloscyllium punctatum Müller and Henle, Syst. Plagiost., i, 1838, p. 18. *Ex* Kuhl and Van Hasselt MS. Java. *Id.* Ogilby and McCulloch, Proc. Roy. Soc. N.S. Wales, xlii, 1909, p. 287, pl. xliii, fig. 2 and text-fig. 1 (references, etc.). *Id.* Ogilby, Mem. Qld. Mus., v, 1916, pp. 77 and 93. *Id.* Whitley, Austr. Zool., iv, 1926, p. 227 (North-west Islet, Qld.) and p. 318 (Isopod parasite).

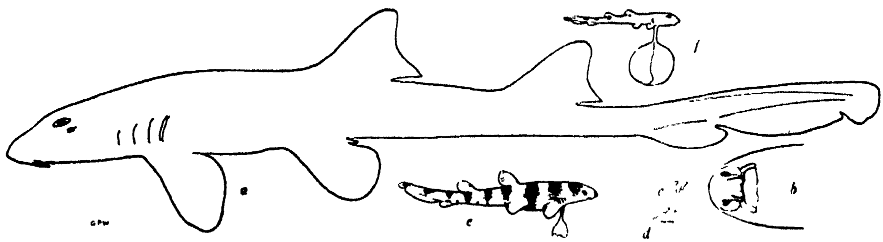

FIGURE 1.

Chiloscyllium punctatum Müller and Henle. *a*, a specimen from North-west Islet, Queensland; *b*, ventral surface of head; *c*, teeth; *d*, dermal denticles of same specimen (original); *e*, fœtus from Moreton Bay, Queensland (after Ogilby and McCulloch); *f*, a smaller (68 mm.) fœtus from North-west Islet (original). [G. P. Whitley, *del.*

The figure represents an immature male (No. IA.4029), nearly 500 mm. long, from North-west Islet, Capricorn Group, Queensland; collected by Messrs. M. Ward and W. Boardman. At the same place, Mr. F. A. McNeill later collected a 68 mm. fœtus with external gills. This is figured together with a copy of Ogilby and McCulloch's illustration of a larger embryo from Moreton Bay.

Family SCYLIORHINIDÆ.

Genus **Atelomycterus** Garman, 1913.

Atelomycterus marmoratus (Raffles).

(Plate xxxviii, fig. 1.)

Scyllium marmoratum Raffles, Mem. Raffles, Feb., 1830, p. 693. Sumatra. *Id.* Smedley, Journ. Malay Br. Roy. Asiat. Soc., v, 2, 1927, p. 355 (China Sea; eggs and young).

? *Scyllium maculatum* Gray, Illustr. Ind. Zool., July, 1830, pl. xcviii. India. Not *Scylium maculatum* Eichwald, 1819 (*fide* Sherborn, Index Anim.).

Scyliorhinus marmoratus McCulloch, Proc. Linn. Soc. N. S. Wales, xxxv, 1910, p. 688 (Port Darwin, north Australia).

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[1] Ogilby and McCulloch.—Proc. Roy. Soc. N. S. Wales, xlii, 1909, p. 290.

Atelomycterus marmoratus Garman, Mem. Mus. Comp. Zool. Harvard, xxxvi, 1913, p. 100, and of modern authors.

The Australian Museum specimen (No. I.5269) recorded from Port Darwin, north Australia, by McCulloch (1910) is here figured. It is apparently correctly identified as this species, but its colour-pattern differs considerably from that figured in Day's "Fishes of India". I have only seen this one specimen, which was collected by Messrs. Christie and Godfrey, but comparison with extra-Australian specimens might prove it to be deserving of varietal or subspecific distinction.

Genus Cephaloscyllium Gill, 1861.

Cephaloscyllium isabella laticeps (Duméril).

(Text-fig. 2.)

Squalus isabella Bonnaterre, Tabl. Encycl. Meth., Ichth., 1788, p. 6. Based on "L'Isabelle" Broussonet, Mem. Acad. Roy. Sci. Paris, 1780, p. 648, No. 1, vernac. Nouvelle-Zealande (Solander and Banks). Spelt *S. sabella* by Gmelin, 1789.

Scyllium? lima Richardson, Rept. 12th meet. Brit. Assn. Adv. Sci., 1842 (1843), p. 29. *Ex Squalus lima* Parkinson MS. Eaheenomauwee, New Zealand.

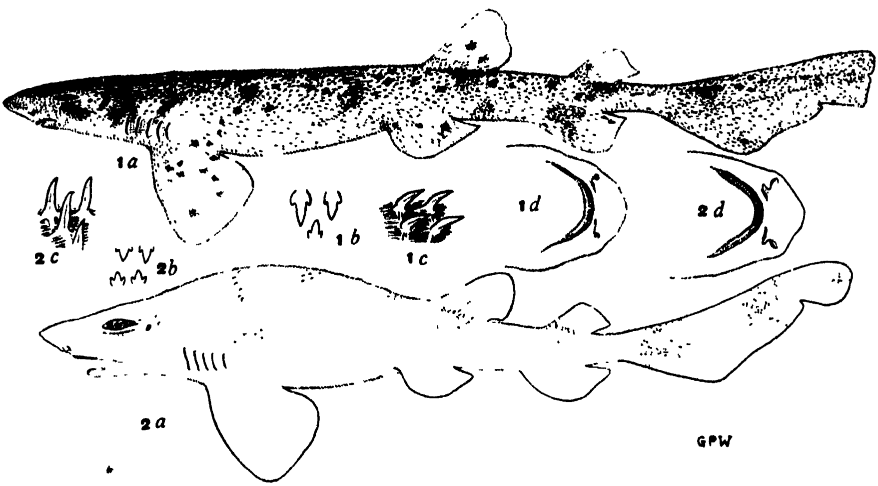

FIGURE 2.
Cephaloscyllium isabella laticeps (Duméril). 1, a virtual topotype from the Derwent River, Tasmania; 2, holotype of *C. i. laticeps* forma *nascione* Whitley from off Montague Island, New South Wales. *a*, lateral view; *b*, teeth enlarged; *c*, dermal denticles enlarged; *d*, ventral surface of head.
[G. P. Whitley, *del.*

Scyllium laticeps Duméril, Rev. Mag. Zool., xxxiv, 1853, p. 84, pl. iii, fig. 2; Hist. Nat. Poiss., i, 1, 1865, p. 323, pl. viii, fig. 1 (egg). Australia.

Cephaloscyllium isabella McCulloch, Zool. Res. Endeav., i, 1911, p. 6. *Id.* Kershaw, Vict. Nat., xliv, 10, 1928, p. 290, and of modern authors.

Cephaloscyllium isabellum Garman, Mem. Mus. Comp. Zool. Harvard, xxxvi, 1913, p. 79 (refs.).

The Swell Shark, as this species is called, is capable of distending its body with sea-water; the eggs are flanged, not smooth, and specimens of them in the

Australian Museum from off Eden, Disaster Bay and Green Cape indicate that this species breeds in southern New South Wales. Illustrated here is a topotypical *laticeps* form from the Derwent River, Tasmania. It is 268 mm. long and was collected by Mr. Melbourne Ward. A slightly smaller (250 mm.) specimen, collected by Mr. W. Boardman, was trawled in 90 fathoms, 24 miles N.N.E. of Montague Island, New South Wales, on Sept. 4, 1926. This specimen is much lighter in colour than the Tasmanian one, and may be named forma *nascione*, nov., as it differs in the shape and position of the fins, form of nostrils, and other minor details, as shown in the figures, from the forma *laticeps*, which is again apparently distinct from the true New Zealand *Cephaloscyllium isabella isabella*, which has base of anal equal to its distance from lower caudal lobe.

Family CARCHARHINIDÆ.

Genus **Galeolamna** Owen, 1853.

Galeolamna greyi Owen.

Galeolamna greyi Owen, Descr. Cat. Osteol. Roy. Coll. Surgeons, i, 1853, p. 96, no. 427, South Australia. Type in Museum of Roy. Coll. Surgeons.

Owen's name has been overlooked by ichthyologists, and must now be added to the Australian list. His description is brief, but apparently refers to the South Australian Whaler Shark, a species which has been figured by Waite[2] as *Carcharinus brachyurus*.

In the same work, Owen names three species of rays from South Australia: *Raia acutidens* (p. 106), *R. parvidens* (p. 106) and *R. molaridens* (p. 107), but as he only gives a few words on their teeth, these species are unrecognizable and virtual *nomina nuda* and I propose to dispose arbitrarily of his names by making them synonyms of *Raja lemprieri* Richardson.[3]

Family GALEIDÆ.

Genus **Notogaleus** Whitley, 1931.

Notogaleus Whitley, Austr. Zoologist, vi, 4, Feb. 13, 1931, p. 310. Orthotype, *Galeus australis* Macleay.

This genus is the Australian representative of the European *Galeus*, *Eugaleus* or *Galeorhinus* of authors, from which it differs in the disposition of the fins and in colour. The acute serrated teeth distinguish it from the Mustelidæ, which are otherwise superficially similar. Sherborn lists the genus *Emissola* Jarocki[4] in his *Index Animalium* as a genus of Squalidæ. I have not seen Jarocki's work, but his name, which has been generally overlooked, probably refers to the European Tope, which is called "l'Emissole" in French.

Notogaleus australis (Macleay).

(Text-fig. 3.)

Galeus canis Günther, Cat. Fish. Brit. Mus. viii, 1870, p. 379. Tasmanian record only. *Id.* Klunzinger, Arch. Naturg., xxxviii, 1, 1872, p. 45 (Murray R.). *Id.* Castelnau, Proc. Zool. Acclim. Soc. Vict., i, 1872, p. 216 (Hobson's Bay). Not *Galeus canis* Bonaparte 1834.

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[2] Waite.—Rec. S. Austr. Mus., ii, 1, April 28, 1921, p. 12, fig. 8.

[3] Richardson.—Zool. Voy. Erebus and Terror, 1845, p. 34, pl. xxiii. Port Arthur, Tasmania.

[4] Jarocki.—Zoologiia, iv, 1822, p. 448.

Galeus sp. Macdonald, Proc. Zool. Soc. Lond., Nov., 1873, p. 312. Flinders I., Bass Strait (Haslar Hospital Museum).

Galeus australis Ramsay, Proc. Linn. Soc. N. S. Wales, v, 1, Aug., 1880, p. 96. Nude name. Port Jackson. *Id.* Macleay, Proc. Linn. Soc. N. S. Wales, vi, 2, Sept. 12, 1881, p. 354; Descr. Cat. Austr. Fish, ii, 1881, p. 290. Port Jackson, N. S. Wales. Types in Macleay Mus., Univ. Sydney. *Id.* McCoy, Prodr. Zool. Vict., i, dec. vii, 1882, p. 13, pl. lxiv, fig. 2 (Hobson's Bay).. *Id.* Ogilby, Cat. Fish. N. S. Wales, 1886, p. 2, and Cat. Fish. Austr. Mus., i, Paleich., 1888, p. 3 (Port Jackson). *Id.* Waite, Rec. Canterb. Mus., i, 2, 1909, p. 139, pl. xv (New Zealand). *Id.* Ogilby, Proc. Roy. Soc. Qld., xxi, 1908, p. 23 (Moreton Bay, Q.). *Id.* McCulloch, Zool. Res. Endeav., i, 1911, p. 9. *Id.* Engelhardt, K. Akad. Wiss. Berlin, iv, Suppl.-Bd. 3, i, 1913, p. 32. *Id.* Ogilby, Mem. Qld. Mus., v, 1916, pp. 78 and 93. *Id.* Waite, Rec. S. Austr. Mus., ii, 1921, p. 13, fig. 12, and Fish. S. Austr. 1923, p. 29, and figs.

Galeorhinus australis Waite, Austr. Mus. Mem., iv, 1899, p. 34 (Morna Pt., N.S.W.). *Id.* Hutton, Index Faun. N.Z., 1904, p. 54. *Id.* McCulloch, Proc. Linn. Soc. N. S. Wales, xlvi, 1921, p. 459, pl. xxxvii, figs. 5–7, and Austr. Zool. Handbook, i, 1922, p. 6, fig. 12*a*. *Id.* Phillipps, N.Z. Journ. Sci. Tech., vi, 1924, p. 259, fig. 2 (N. Zealand; dorsal and anal opposite).

Mustelus australis Waite, Mem. N. S. Wales Nat. Club, i, 1904, p. 7.

Eugaleus australis Waite and McCulloch, Trans. Roy. Soc. S. Austr., xxxix, 1915, p. 460 (Great Australian Bight).

Carcharhinus cyrano Whitley, Austr. Mus. Mag., iv, 3, July 17, 1930, p. 93, fig. of jaws. Port Stephens, New South Wales; July, 1929 (Norman Caldwell). Holotype (jaws of ♀; Regd. No. S.1847) and fœtotype (fœtus from holotype; No. IA.3936) in Australian Museum.

Notogaleus australis Whitley, Austr. Zool., vi, 4, Feb. 13, 1931, p. 310.

As *Galeorhinus australis*, the Tope or School Shark of New South Wales has been well described and figured by McCulloch (*loc. cit.*, 1921), but the synonymy given above is noteworthy.

A "Long-nosed Sea Shark" from off Port Stephens, New South Wales, was recently brought before my notice by Mr. Norman Caldwell, of Marine Industries, Ltd., who presented the jaws and a photograph of a female over six feet long to the Australian Museum. A fœtus taken from this shark is here figured. I provisionally named it *Carcharhinus cyrano*, but that name must fall as a synonym of Macleay's species.

In McCulloch's card-index there is a sketch labelled "Carchariidæ" which can be identified as this species. He noted: "One or two specimens of this shark were captured in almost every haul of the trawl in about 60 fathoms off the east of Babel Island. Specimen sketched was captured in 74–79 fathoms, 17 miles S.E. of Bruni Island, Tasmania.

"Total length, from tip of snout to end of tail, 1,465 mm. Tip of nostril to anterior base of first dorsal, 517. Height of first dorsal, 112; base of first dorsal, 133. Interdorsal space, 380. Height of second dorsal, 40; base of second dorsal, 55. Length of tail, 295. Length of lower lobe, 125. Anterior border of eye to tip of snout, 130. Eye, 37. Posterior margin of eye to anterior gill-opening, 115. Length of pectoral, 210.

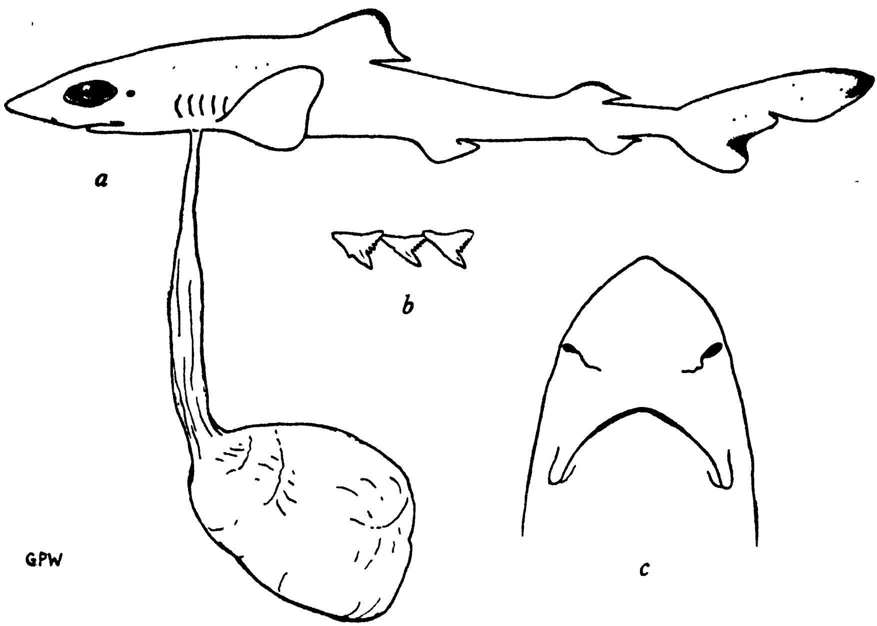

FIGURE 3.
Notogaleus australis (Macleay). *a*, fœtotype of *Carcharhinus cyrano* Whitley from Port Stephens, New South Wales; *b*, teeth from mother of *a*; *c*, ventral surface of head of *a*.

[G. P. Whitley, *del.*

"Snout acute. Eye [when viewed laterally] over middle of mouth. Spiracle minute, placed well behind eye. Gill-openings subequal, the last placed over the base of the pectoral. Angle of mouth with a groove extending a short distance along each jaw. Origin of dorsal behind posterior margin of pectoral; posterior angle somewhat produced and acute. Second dorsal a little in advance of the anal, the two fins subequal in size. Ventrals a little nearer the second than the first dorsal, almost midway between the two. No pit at base of caudal above, a shallow one below. Nostrils nearer mouth than tip of snout. Teeth preserved. Registered E.4909.

"Light grey in colour, belly whitish. Fins without dark marks."

Family SQUALIDÆ.

Deaniops, gen. nov.

Orthotype.—*Acanthidium quadrispinosum* McCulloch[5] = *Deaniops quadrispinosus.*

The type of McCulloch's species was a shark over two feet long, but I have seen a much larger specimen. The logotype of the genus *Acanthidium* Lowe[6] is *A. pusillum* Lowe which was figured in that author's "Fishes of Madeira". That

[5] McCulloch.—Biol. Res. Endeav., iii, 1915, p. 100, pl. xiv, figs. 5-8. South of Gabo Island, Victoria. Type on deposit in Australian Museum.
[6] Lowe.—Proc. Zool. Soc. London, vii, Oct., 1839, p. 91.

species, Lowe stated, varies in length from only eleven to twelve inches. Apart from size, however, McCulloch's species differs from Lowe's in several characters which are independent of age or growth. In *A. pusillum* the snout is much shorter, the first dorsal fin very much smaller, and the base of the ventrals comparatively longer than in *quadrispinosum*, so as the two are obviously not congeneric, I propose the new name *Deaniops* for the Australian form.

Family RHINOBATIDÆ.

Genus **Trygonorrhina** Müller and Henle, 1838.

Trygonorrhina fasciata guanerius, subsp. nov.

The South Australian Fiddler Ray, which has been figured by Waite,[7] differs markedly from the typical New South Wales form in the disposition and nature of its colour-markings. The differences may be better appreciated by comparing Waite's figure with that of McCulloch[8] than conveyed by written description. Comparison of specimens in the National Museum, Melbourne, from Port Jackson, New South Wales, and Glenelg, South Australia, demonstrated that the two forms are worthy of nominal separation, so I propose the new name *guanerius* for the South Australian subspecies.

Family TORPEDINIDÆ.

Notastrape, gen. nov.

Orthotype.—*Notastrape macneilli*, sp. nov.

Eyes functional, not far in advance of the spiracles, which are without fringes or papillæ. Tail shorter than the disc, which is broader than long. Two dorsal fins. Caudal fin large.

Notastrape macneilli, sp. nov.

Torpedo fairchildi McCulloch, Rec. Austr. Mus., xii, 1919, p. 171, pl. xxv. Off Green Cape, New South Wales; 49 fathoms. Not *T. fairchildi* Hutton, Cat. Fish. N. Zeal., 1872, p. 83, pl. xii, fig. 134.

The holotype of this new species, in the Australian Museum, has been described by the late A. R. McCulloch and figured by Mr. F. A. McNeill, who collected it. It was evidently wrongly identified as the Neozealanic *Torpedo fairchildi* which Hutton described as having the dorsal and ventral fins in different relative positions. The Australian species, here renamed, is chocolate brown in colour above and white below, whereas the New Zealand type is uniform greyish-black above and has a more prominent snout, and disc much broader anteriorly.

Family MOBULIDÆ.

Dæmomanta, gen. nov.

Orthotype.—*Manta alfredi* Stead.

Head short and very wide. Mouth terminal. Teeth ?. A long cephalic fin with rounded extremity on each side of mouth. Eye large, lateral, situated at junction of pectoral and cephalic fins. Nostrils wide apart and connected by a groove about as wide as mouth.

[7] Waite.—Rec. S. Austr. Mus. ii, 1, April 23, 1921, p. 27, fig.

[8] McCulloch.—Proc. Linn. Soc. N. S. Wales, xlvi, 1921, p. 460, pl. xxxviii, figs. 1-2.

Size very large. Disc much broader than long. Pectorals acutely pointed, their posterior margins excavate but not so markedly concave as in *Manta*. Ventrals small, bluntly rounded. One well developed dorsal fin, without spine, present before tail. Tail distinct from disc, long and pointed, without a caudal fin and apparently without a serrated spine. Skin somewhat tubercular.

Similar to *Manta* Bancroft as described by Jordan and Evermann,[9] but with cephalic horns farther apart and posterior margins of pectoral fins less concave. Probably other differences would be apparent if good specimens of these giant rays from America and Australia could be compared.

Dæmomanta alfredi (Stead).
(Plate xxxvii, figs. 1-4.)

Ceratoptera alfredi Krefft, Industr. Progr. N. S. Wales, Rept. Intercol. Exhib., 1870, Sydney, 1871, p. 778. Port Jackson; 15 feet wide. *Nomen nudum.* Chirotype, No. I.1731, in Australian Museum. *Id.* [Hill], Sydney Mail, May 27, 1871, p. 394 (near Watson's Bay). *Id.* Macleay, Proc. Linn. Soc. N. S. Wales, vi, Sept. 12, 1881, p. 381, and Descr. Cat. Austr. Fish., ii, 1881, p. 317. *Id.* Tenison-Woods, Fish. and Fisher. N. S. Wales, 1882, p. 99. *Id.* Ramsay, Cat. Exh. N. S. Wales Court, 1883, p. 22, and as *Dicerobatus* sp. *Id.* Ogilby, Cat. Fish. N. S. Wales, 1886, p. 6. All virtually *nomina nuda.*

Manta alfredi Waite, Mem. N.S.W. Nat. Club, ii, Nov. 7, 1904, p. 11. Undescribed. *Id.* Stead, Fish. Austr., 1906, p. 233. *Id.* McCulloch, Austr. Zool., i, 7, Nov. 27, 1919, p. 227, pl. xviii, fig. 43*a* (type figured); Austr. Zool. Handbook, i, 1922, p. 13, pl. iii, fig. 43*a*; Austr. Mus. Mem., v, 1929, p. 31.

This species was named by Krefft many years ago, but not described, and the chirotype, a damaged specimen, was reconstructed to such an extent that several ichthyologists would not venture to diagnose the species. The name *Ceratoptera alfredi*, proposed by Krefft, was thus a *nomen nudum.* Waite, recognizing that the generic name was preoccupied, placed the species in *Manta*, an American genus, but the name still had no validity until Stead in 1906 briefly described the species, and McCulloch, in 1919, gave a figure of Krefft's type in his New South Wales "Check-List".

The generic diagnosis given above is as descriptive of the species as is practicable with Krefft's specimen, which has either shrunken or been made smaller in mounting, as it is not now 15 feet wide as stated by Krefft. In an old photograph album in the Australian Museum, I have discovered some pictures of Krefft standing beside what is evidently the type-specimen of this species and the best of these is here reproduced. Other specimens have been caught off the New South Wales coast from time to time, but have not been preserved. Such a one was, for instance, caught off Cape Hawke and illustrated in the *Sunday News*, Sydney, April 22, 1923, p. 23; photographs of this specimen are also given here.

In an exercise book of the late E. P. Ramsay, I find some sketches of another specimen evidently referable to this species. This is a young male from New South Wales. From notes on the sketches, the following measurements are evident:

[9] Jordan and Evermann.—Bull. U.S. Nat. Mus., xlii, March, 1896, p. 92.

Total length without tail	24·0	inches
Width of disc	56·0	„
Pectoral margins	27·0	„
Interorbital space	9·1	„
Centre of eye to tip of cephalic fin	4·9	„
Maximum diameter of eye	1·0	„
Lower lip	5·5	„
Width of mouth	5·6	„
Dorsal fin	2·9	„
Caudal spine	2·7	„
Tail	48·5	„

"Colour a rich plum. White underneath. Jan. 9th, 1883."

Waterhouse[10] notes *Ceratoptera alfredi* from Roviana, Solomon Islands, but this is probably another species of the family Mobulidæ.

Part II.—Class PISCES.

Family MURÆNIDÆ.

Genus **Uropterygius** Rüppell, 1838.

Uropterygius obesus, sp. nov.

(Plate xxxix, fig. 1.)

Uropterygius marmoratus Whitley, Journ. Pan-Pacif. Res. Inst., ii, 1, 1927, p. 8, and Fish. N. S. Wales (McCulloch), 1927, add. Off Montague Island, New South Wales. Not *Gymnomurœna marmorata* Lacépède, 1803.

Head bulbous, contained nine times in total length, its upper profile concave between the eyes and curving into the convex and rather overhanging snout anteriorly. Eye small, overlaid with adipose tissue and without free margin. Anterior nostrils in large tubes on the anterior portion of the snout; posterior ones pore-like, with scarcely elevated rims and situated above and before eyes. Lower jaw longer than upper, the rictus extending far behind eyes. Lips thick. Three pores along each side of upper jaw exteriorly and some smaller ones scattered on chin. Each jaw with a single lateral row of about seventeen strong conical teeth directed slightly backwards and depressible. A depressible fang behind the intermaxillary teeth and some small teeth around the anterior part of the upper jaw. Vomer apparently toothless; the roof and floor of the mouth are covered with thick, plicated skin. Tongue not free. Mouth not closing completely. Gill-slits small, lateral, slightly oblique.

Body very elongate and somewhat tapering, not much compressed except towards tail, entirely covered with tough, smooth skin. Belly rounded. Dorsal and anal fins reduced to low fatty folds anteriorly; the dorsal fin first becomes apparent well behind the gill-slits and the anal in the posterior half of the fish, well behind vent and genital orifice. Dorsal and anal rays only visible posteriorly where they are confluent with the small caudal fin. Pectorals none. Some lateral line pores visible at the shoulder, but soon disappearing posteriorly.

Owing to the large size of this eel, the following measurements are mostly approximate: Eye, 9 mm.; interorbital, 30; maximum length of upper jaw 70, of lower 75; head, 165; snout, 35; depth of body 105, of head 113. Distance from snout to vent 780 mm., rather longer than that from vent to tip of tail, 735.

[10] Waterhouse.—Roviana and English Dict., 1928, p. 168.

General ground-colour yellowish-cream, densely overlaid with brown vermiculations, as shown in the figure, which extend over the ventral surface as well as head, body and fins. Area around rictus and inside mouth pinkish. Gill-slit putty-coloured. Caudal and last dorsal and anal rays tinged with blackish. Some light patches on the body and tail where the brown markings are absent may have been caused by rubbing the sides against rocks or by wounds when the fish was alive. The eye was originally blackish with a yellow iris surrounded by a blackish ring with some smoky speckles, but after preservation in formalin it has turned milky-blue.

Described and figured from the holotype, a specimen five feet long, from off Montague Island, New South Wales. Austr. Mus. Regd. No. IA.3888.

A paratype from the same locality (No. IA.2658) is only two and a half feet long and has the vertical fins less covered over with fat than in the holotype, so that the dorsal originates just over the gill-slits and the anal commences immediately behind the vent. It has a depressed fang, followed by a single series of minute teeth on the vomer, and there are up to five depressible fangs inside the outer row of teeth along the sides of the upper jaw. Its mouth closes completely and the jaws are subequal. All these characters seem due to its immaturity.

Localities.—Nine miles N.E. of Montague Island, New South Wales; about 70 fathoms, May, 1929. Presented by Mr. Alec Ward. Holotype (Austr. Mus. Regd. No. IA.3888), plastotype (Nos. L.1676, T.627).

South of Montague Island, N.S.W.; 40–50 fathoms, April, 1926 (Captain Reid); paratype (No. IA.2658), recorded as *Uropterygius marmoratus*.

Trawled off Cape Everard, Victoria (Mr. A. A. Murrell). No. IA.4072.

Range and station.—Southern New South Wales and Victoria, in fairly deep water on the continental shelf. A living specimen in Taronga Park Aquarium, Sydney, lies with the head protruding from a heap of rocks in the usual moray fashion.

Affinities.—*Uropterygius concolor* Rüppell,[11] the type of the genus, differs from my new species in having the vertical fins still more reduced and in its uniform colour. *Gymnomuræna marmorata* Lacépède[12] has the anus nearer the head than the tip of the tail and the outline of the body in transverse section is more triangular. *Gymnomuræna macrocephalus* Bleeker[13] is more elongate and with lower fins. All the other species of *Uropterygius* known to me differ markedly in coloration from my new species. The slender-headed *U. acutus* Parr[14] may even represent a distinct genus.

Genus **Gymnothorax** Bloch, 1795.

Gymnothorax cribroris, sp. nov.

(Plate xxxix, fig. 2.)

Anguilla richardsoni Saville-Kent, Great Barrier Reef Austr., 1893, p. 370. Queensland (listed only). Not *Muræna richardsonii* Bleeker.

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[11] Rüppell.—Neue Wirbelth. Abyssin. Fische, 1838, p. 83, pl. xx, fig. 4. Red Sea. Kaup (Cat. Apod. Fish., 1856, p. 105) called this *Uropterygius unicolor*, a needless synonym. *Scuticaria unicolor* Seale, Bull. Mus. Comp. Zool., lxi, 4, May, 1917, p. 94, from the Society Islands, is evidently a new species, *Uropterygius sealei*.

[12] Lacépède.—Hist. Nat. Poiss., v, 1803, p. 648. New Britain.

[13] Bleeker.—Ned. Tijdschr. Dierk., ii, 1864, p. 54. Amboina.

[14] Parr.—Bull. Bingham Oceanogr. Coll., iii, 4, July, 1930, p. 16, fig. 2. West Caicos Island.

Muræna (Gymnothorax) richardsoni Weber and Beaufort, Fish. Indo-Austr. Archip., iii, 1916, pp. 362 and 383. Australian record only.

Gymnothorax sp. McCulloch and Whitley, Mem. Qld. Mus., viii, 2, July 7, 1925, p. 136. On Saville-Kent, 1893.

Several specimens (Austr. Mus. Nos. IA.4619, 5012 and 5027) from North-west Islet, Capricorn Group, Queensland, consistently differ from the original description[15] of *Muræna richardsonii* and from Bleeker's figure[16] in various details, notably in dentition and coloration, and require a new name. The species may be described as follows.

Height (16 mm.) 16·2 in total length (260). Head (30) 8·2 in same. Gill-slit (2) much smaller than eye (3·3) which is nearly 2 in snout (6·5), which is again 2 in cleft of mouth (13). Head and trunk (124) shorter than tail (136). Head and body elongate, somewhat compressed, but thickest in middle of length. Snout conical, compressed laterally. Centre of eye over posterior half of mouth. Upper jaw the longer; lips with spaced ciliate papillæ. Seven teeth around intermaxillary followed on each side by two large teeth before the smaller maxillary ones, interior to which there is a single depressible tooth on each side. Two mesial depressible fangs on intermaxillary and a single row of small teeth on vomer. Mandible with two canines on each side anteriorly, followed by the single row of lateral teeth. Dorsal originating on head in advance of gill-openings. Skin with minute criss-cross folds.

Ground-colour cream on fins and tail, suffused with pinkish on trunk and becoming yellowish on top of head and snout. Ventral surface of head and trunk plain. Sides of head with large brown spots which become mere dots on the vertex and do not extend over the snout. No white spots along lips. Body and fins densely overlaid by a network of brown markings which do not form transverse bands, though on the tail they enclose the ground-colour in rows of white or yellowish spots. Posterior margins of fins cream. An ill-defined smoky blotch at the rictus. A brown blotch immediately over each gill-opening is hardly darker than others on the body.

Described and figured from the holotype (No. IA.5012), a specimen 260 mm. long, collected in May, 1931, at North-west Islet by the writer, who has also taken a similar, though distinctly coloured form, at Rarotonga which will be dealt with separately in a later paper.

The species recorded from Western Australia as *Muræna richardsonii* is quite distinct and has been named *Gymnothorax woodwardi* by McCulloch.[17]

Family CLUPEIDÆ.

Genus Macrura Van Hasselt, 1823.

Macrura Van Hasselt, Algem. Konst. Letter-Bode, 1823 (21), May, 1823, p. 329. Type, "Koelee" Russell, 195 (*fide* Sherborn, Index Anim. (2), xv, May, 1928, p. 3778). Book not available to me.

The genus *Macrura* has been overlooked by ichthyologists and evidently applies to the group of Indo-Australian fishes regarded as *Alosa* by authors.

[15] Bleeker.—Nat. Tijdschr. Ned. Ind., iii, 1852, p. 296. Ceram and Sumatra.
[16] Bleeker.—Atlas Ichth., iv, 1864, p. 100, pl. clxxxvi, fig. 2.
[17] McCulloch.—Rec. W. Austr. Mus., i, 1912, p. 80, fig. 1.

Alosa Cuvier[18] is a later name than Van Hasselt's, and seems to be only strictly applicable to the Shads of Europe. Van Hasselt's name may be regarded as preoccupied, however, by *Macroura* Meuschen, 1778 (Mammalia), *Macrourus* Bloch, 1786 (Pisces), and *Macrurus* Bloch and Schneider, 1801 (Pisces), and the genus, therefore, should, in my opinion, receive a new name. My reason for not giving it one is that there appears to be some obscurity regarding the genotype. Russell[19] figured a Clupeid fish as "Keelee", a native vernacular name, and Bleeker[20] identified Russell's plate as his *Alosa kanagurta*. However, Russell's fish disagrees in fin-formula and length of caudal in relation to head with the one figured by Bleeker, and may be more closely allied to *Alosa macrura* (Kuhl and Van Hasselt MS.) Bleeker, or an allied species.

The fish recorded from the Sir Edward Pellew Group, Gulf of Carpentaria, as *Harengula kanagurta*[21] differs from both accounts in having a much deeper body, and will probably require a new name when the problem of *Macrura* is eventually solved.

Genus Harengula Cuvier and Valenciennes, 1847.

Harengula punctata stereolepis Ogilby.

Clupea punctata Rüppell, Neue Wirbelth. Abyssin. Fische, 1837-8, p. 78, pl. xxi, fig. 2. Red Sea.

Clupea profundis, *torresiensis* and *ranelayi* Saville-Kent, Prelim. Rept. Food-Fish. Qld., 1889, p. 11. *Nomina nuda ex* De Vis MS. Queensland.

Harengula stereolepis Ogilby, Proc. Linn. Soc. N. S. Wales, xxii, June 4, 1895, p. 759. Torres Strait, Queensland.

Harengula punctata Whitley, Rec. Austr. Mus., xvi, 1927, p. 4 (refs. and synonymy).

Specimens bearing De Vis' labels in the Australian Museum demonstrate that the *nomina nuda* listed by Saville-Kent in the genus *Clupea* may be disposed of as synonyms of *Harengula stereolepis* Ogilby, the Queensland form of *punctata* Rüppell. The "Sardines" of Murray Island remarked upon by Yonge[22] are doubtless this species also.

Maugeclupea, gen. nov.

Orthotype, *Clupea bassensis* McCulloch[23] = *Maugeclupea bassensis*.

McCulloch employed the subgeneric name *Pomolobus* Rafinesque[24] for his *Clupea bassensis*, but his choice was unfortunate, as Rafinesque's genus applies to an Ohio species which differs in many characters from the Australian one, which is not congeneric. It may be noted that *Pomolobus* was emended to *Pomatolobus*, an overlooked synonym, by Agassiz.[25] *Clupea bassensis* obviously requires a new

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[18] Cuvier.—Règne Anim., Ed. 2, ii, April, 1829, p. 319. Tautotype, *Clupea alosa* Linné, Syst. Nat., Ed. 10, 1758, p. 318, from European seas.

[19] Russell.—Fish. Vizagapatam, 1803, p. 75, pl. cxcv.

[20] Bleeker.—Atlas Ichth., vi, 1872, p. 114, pl. cclxv, fig. 5.

[21] Paradice and Whitley.—Mem. Qld. Mus., ix, 1, 1927, p. 79, pl. xii, fig. 1.

[22] Yonge.—Nature, Nov. 2, 1929, p. 695, fig. 3, and A Year on the Great Barrier Reef, 1930, p. 191, pls. lvi-lviii.

[23] McCulloch.—Zool. Res. Endeavour, i, Dec. 22, 1911, p. 16, pl. iv, fig. 2. Bass Strait and Tasmania. Types on deposit in Australian Museum.

[24] Rafinesque.—Western Review, ii, 3, April, 1820, p. 170; Ichth. Ohiensis, Dec., 1820, p. 38: McCall's Reprint, 1899, p. 89. Haplotype, *P. chrysochloris* Rafinesque.

[25] Agassiz.—Nomencl. Zool., 1846, Index Univ., p. 305. Type, *Pomolobus chrysochloris* Rafinesque, by present designation.

generic name, and may be called *Maugeclupea*, the diagnostic characters being: Teeth present in jaws. Depth of the elongate body less than length of head. Ventral scutes small. Ventral fins each with eight rays, originating a little in advance of the vertical of the dorsal and reaching half-way to vent when adpressed.

Family MYCTOPHIDÆ.

Subfamily SCOPELOPSINÆ, nov.

Genus **Scopelopsis** Brauer, 1906.

Scopelopsis Brauer, Wiss. Ergeb. Deutsch. Tiefsee-Exped. Valdivia xv, 1906, p. 146. Haplotype *S. multipunctatus* Brauer from off South Africa. *Scolepopsis* in Index Zoologicus.

Scopelopsis caudalis, sp. nov.

D.19. A.23. P.13. V.8. C.17. L.lat.42. L.tr. 3½/1/4½.

Head (15 mm.) 3·5, depth of body (12·5) 4·2 in standard length (53). Orbit (4) 3·7, interorbital (5) 3, snout (2·5) 6, maxillary (11) 1·3 in head.

Form elongate, compressed. A median crest on snout flanked by cavernous olfactory pits. Upper profile of head more rounded and rising more steeply than lower. Scales of head with entire edges and each bearing a small central photophore. About four photophores below the mandible on each side. Gape of mouth very wide, the maxillary extending more than an eye-diameter behind the eye. Preopercular margin very oblique. Narrow bands of minute conic teeth on jaws, vomer, palatines, and tongue. Gill-rakers numerous, long and slender, and extending well forward into mouth.

Body deepest below dorsal origin, covered with hard, adherent, crudely ctenoid scales, each one of which bears a small central photophore. A light area above the caudal peduncle was probably luminous in life.

Dorsal and anal bases equal in length (17 mm.). Adipose dorsal fin rayed and situated over the last anal ray. Pectorals small, their longest rays (complete?) subequal to eye-diameter. Ventrals reaching vent. Caudal strongly forked, its lobes subequal to maxillary; the median rays bear one or two, and the outward rays six or seven small photophores.

General colour in alcohol, dark brown. Very light yellow on interorbital space and above caudal peduncle. Photophores mostly milky-blue, sometimes surrounded by a dark brown ring. Fins whitish except the caudal which has a brown-speckled appearance due to the photophores.

Described from the unique holotype of the species, a specimen 53 mm. in standard length or just over 2½ inches in total length. Austr. Mus. regd. no. IA.2427. Collected at Lord Howe Island by the late Allan R. McCulloch, who found it on the lagoon beach seven or eight years ago.

The long maxillary, oblique preoperculum, and long caudal fin bearing photophores appear to distinguish this species from the genotype and hitherto only known species of the genus, *S. multipunctatus* Brauer, of which Barnard gave an extended description in his Monograph of the Marine Fishes of South Africa (1925).

Family SERRANIDÆ.

Genus **Othos** Castelnau, 1875.

Othos Castelnau, Vict. Offic. Rec. Philad. Exhib., 1875, p. 43. Haplotype, *O. cephalotes* Castelnau [= *Plectropoma dentex* Cuv. and Val.].

Colpognathus Klunzinger, Sitzb. Akad. Wiss. Wien, lxxx, 1, 1879, p. 339. Orthotype, *Plectropoma dentex* Cuv. and Val. Name preoccupied by *Colpognathus* Wesmael, 1844, a genus of Insecta (*fide* Sherborn).

Klunzinger's name, which has been in common use, is preoccupied, but *Othos*, which has been wrongly regarded as a Brotulid, is earlier as a name and identical with *Colpognathus*, and must therefore replace it.

Othos dentex (Cuvier and Valenciennes).

Plectropoma dentex Cuvier and Valenciennes, Hist. Nat. Poiss., ii, Oct., 1828, p. 394. King George's Sound, Western Australia (Quoy and Gaimard). *Id.* Richardson, Zool. Voy. Erebus and Terror Fish., 1848, p. 117, pl. lvii, figs. 3-5 (King George's Sound). *Id.* Klunzinger, Sitzb. Akad. Wiss. Wien, lxxx, 1, 1879, p. 337, pl. i, fig. 1 (King George's Sound).

Plectropoma richardsonii Günther, Proc. Zool. Soc. Lond., 1861 (April 7, 1862), p. 391, pl. xxxviii. Fremantle, W. Australia. Holotype in British Museum.

Othos cephalotes Castelnau, Vict. Offic. Rec. Philad. Exhib., 1875, p. 44. Beach near Swan River, W. Australia. *Id.* McCulloch, Austr. Mus. Mem., v, 1929, p. 356 (in Brotulidæ).

Colpognathus dentex Boulenger, Cat. Perc. Fish. Brit. Mus., 1895, p. 310, fig. 21 (Adelaide, S. Austr.; King George's Sound and Fremantle, W. Austr.), and of authors.

Richardson and others have given good figures of Cuvier and Valenciennes' species, which is the type of *Colpognathus* Klunzinger, preocc. A hitherto unsuspected synonym is *Othos cephalotes* Castelnau, the prolix description of which, based on portions of a skull and a rat-gnawed skin, agrees excellently with figures and descriptions of *dentex*. Castelnau's statement that the ventral fins are "jugular" evidently confused McCulloch, who regarded his species as an aberrant Brotulid. Another mistake of Castelnau's is his statement that the eye is contained seven times in the length of the fish, when "in the head" was obviously intended. These are minor discrepancies, however, and the correct name for this species is thus *Othos dentex* (Cuv. and Val.).

Family HISTIOPTERIDÆ.

Evistiopterus, gen. nov.

Orthotype, *Histiopterus acutirostris* Temminck and Schlegel[26] = *Evistiopterus acutirostris*.

Anterior profile of head very irregular; orbital region, snout, and jaws very prominent. End of maxillary not covered by preorbital; vomer toothless. Dorsal spines four, the third shorter than the fourth and all lower than the rays of the soft dorsal. Anal spines three, the second largest, but the third longest.

This new generic name will replace *Evistias* Jordan[27] preoccupied by *Evistius* Gill,[28] a genus of Labracoglossid fishes of identical etymological derivation.

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[26] Temminck and Schlegel.—Fauna Japon. Pisces, 1844, p. 88. Japan.

[27] Jordan.—Proc. U.S. Nat. Mus., xxxii, 1907, p. 237.

[28] Gill.—Mem. Nat. Acad. Sci. Wash., vi, 1893, pp. 114 and 123.

Family BELONIDÆ.

Genus **Platybelone** Fowler, 1919.

Platybelone dorsalis, sp. nov.

Belone persimilis Günther, Journ. Mus. Godeff., vi, 16, Fische der Südsee, iii, 8, 1909, p. 349. North-western Australian specimen in British Museum only. *Id.* McCulloch, Austr. Mus. Mem., v, 1929, p. 101.

Included in Günther's original description of the Hawaiian *Belone persimilis* is an atypical north-western Australian specimen which requires a new name. Günther notes it as having D.16; A.19; diameter of orbit, 11 mm.; interorbital space, 9·5 mm.; postorbital, 23 mm. Length, 17 inches. The increased number of dorsal rays is the main character distinguishing the Australian species.

Family MUGILIDÆ.

Genus **Ellochelon** Whitley, 1930.

Ellochelon vaigiensis (Quoy and Gaimard).

Mugil vaigiensis Quoy and Gaimard, Voy. Uran. Physic., Zool., 1825, p. 337, pl. lix, fig. 2. Waigiou. *Id.* Günther, Cat. Fish, Brit. Mus. iii, 1861, p. 435, and fig.

Mugil ventricosus Castelnau, Vict. Offic. Rec. Philad. Exhib., 1875, p. 32. Nicol Bay, Western Australia. Name preoccupied by *Mugil ventricosus* Richardson, Rept. 15th Meet. Brit. Assn. Adv. Sci, 1845 (1846), p. 249, a Chinese mullet.

The name *Mugil ventricosus* Castelnau is preoccupied, but the species does not appear to require a new name, as Castelnau's types seem to have been merely small bloated or deformed specimens of *Ellochelon vaigiensis*, which is recorded from north-western Australia.

Family BRANCHIOSTEGIDÆ.

Genus **Branchiostegus** Rafinesque, 1815.

Coryphænoides Lacépède, Hist. Nat. Poiss., iii, 1802, p. 219. Haplotype, *C. hottuynii* Lacépède, based on "Hottuyn. Act. Haarl. 20, 2, p. 315" from Japan. Name preoccupied by *Coryphænoides* Gunnerus, Trondhiemska Selsk. Skrift., iii, 1765, pp. 50 and 58 (*fide* Sherborn, Index Anim.), another genus of fishes.

Branchiostegus Rafinesque, Analyse de la Nature, 1815, p. 86 (*fide* Sherborn). "Substitute for *Coryphænoides* Lacépède, not of Gunner"—*fide* Jordan, Gen. Fish., 1919, p. 90. Type *C. hottuynii* Lacépède.

Latilus Cuvier and Valenciennes, Hist. Nat. Poiss., v, July, 1830, p. 368. Logotype, *L. argentatus* C. and V., selected by Jordan, Tanaka, and Snyder, Journ. Coll. Sci. Imp. Univ. Tokyo, xxxiii, 1, 1913, p. 187.

Branchiostegus wardi, sp. nov.

(Plate xxxix, fig. 3.)

Branchiostegus sp. Marshall, Mem. Qld. Mus., ix, 2, June 16, 1928, p. 189. Off Noosa Heads, Queensland. Specimen (No. I.4389) in Queensland Museum.

Br.6; D.vii/15(16); A.ii/11(12); P.i/17; V.i/5; C.13. Sc.76 to hypural. L.tr.8/1/23. 14 gill-rakers on lower limb of 1st gill-arch.

Head (*circa* 95 mm.) subequal to depth (96) and 3·47 in standard length (*c.* 330). Eye (20) 4·7 in head or 1·5 in snout (31), which is 3 in head and longer than interorbital (29).

Vertex of head with a low crest, 69 mm. long, before dorsal fin. Top of head before interorbital soft and tumid. An outer row of small canines and an inner band of villiform teeth in each jaw. About ten transverse rows of scales on cheeks. Depth of caudal peduncle about 2½ in head.

Other general characters as in *Branchiostegus ilocanus* Herre.[29]

General colour, in formalin, light brownish above and shading to white below, without defined cross-bands. Crest on head, suprascapula, pectoral base and axilla yellow. Some faint orange or yellow blotches along lateral line. Front of head faint lavender. Eye milky bluish. Pectorals light greyish, with a narrow black margin to the first two rays. Dorsals greyish, with yellow along the base and disposed irregularly on the membranes; a narrow, smoky, inframarginal stripe. Anal and ventrals uniform smoky grey. Uppermost caudal rays grey; most of upper caudal lobe yellow, brightest on sixth ray; seventh and part of eighth ray grey; an oblique band of bright yellow crosses base of lower caudal lobe and extends along parts of eighth and ninth rays; lowest part of caudal lobe dark greyish, with a whitish margin below.

Described from the holotype, about 330 mm. in standard length. Trawled in 50-60 fathoms, off Port Stephens, New South Wales; September 18th, 1931. Australian Museum Regd. No. IA.5130.

Named after Mr. Alec Ward, who collected the specimen, and who has obtained many rare and interesting fishes on board the trawlers in recent years.

Branchiostegus wardi is closely allied to the Philippine *B. ilocanus* Herre, 1928, but differs from the original description and figure of that species in having more rows of cheek-scales and more scales on body. The first two dorsal spines are close together, but not united as in Herre's species. In the Australian form, the proportions of the head are quite different from those of *B. ilocanus*.

Family CHÆTODONTIDÆ.

Genus **Chelmon** Cloquet, 1817.

Chelmon Cloquet, Dict. Sci. Nat., viii, 1817, p. 370. Based on "Chelmon" Cuvier, Règne Anim., Ed. 1, ii, "1817" = Dec., 1816, p. 344, vernac. Logotype, *Chætodon rostratus* Linné, by present designation.

Chelmo Schinz, Das Thierreich (Cuvier), ii, 1822, p. 532. *Ex* Cuvier, vernac. Logotype, *Chætodon rostratus* Linné.

Chelmonus Jarocki, Zoologiia, iv, 1822, p. 260 (*fide* Sherborn, Index Anim.).

Of this genus, I recognize two Australian forms, instead of four, as entered in the Check-List[30]: *Chelmon rostratus mulleri* Klunzinger from north-eastern Australia and *C. rostratus marginalis* Richardson (syn. *tricinctus* Castelnau) from Western and north-western Australia.

Family ODACIDÆ.

Genus **Neoodax** Castelnau, 1875.

Neoodax semifasciatus (Cuvier and Valenciennes).

Odax semifasciatus Cuvier and Valenciennes, Hist. Nat. Poiss., xiv, "1839" = Jan., 1840, p. 299, pl. ccccvii. "Mers des Indes" (Péron).

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[29] Herre.—Philippine Journ. Sci., xxxv, 1, Jan., 1928, p. 32, pl. iii. Ilocos, P.I.

[30] McCulloch.—Austr. Mus. Mem., v, 1929, p. 249.

To the synonymy of this species may now be added *Labrus squalidus* Girard,[31] described from "l'Ile Decrès", nowadays known as Kangaroo Island, South Australia. Girard also (pp. 166 and 271) noted the practically unknown *Balistapodus wittensis* (family Balistidæ) as probably a mutilated *Balistapus lineatus*, of which it may conveniently be regarded as a synonym, thus removing another doubtful species from the Australian list.[32]

Family CARANGIDÆ.

Turrum, gen. nov.

Orthotype, *Turrum emburyi*, sp. nov.

A genus of trevallies of large size and with the general facies of *Caranx*, sensu latissimo, but separable from all the known Carangid genera by the following combination of characters.

Eye small. Teeth present in villiform bands on jaws, vomer, and palatines. Lips not sharp-edged. Gill-rakers not extending forward into mouth. Body deep, compressed, its profiles convex, not angular, that of the dorsal surface being much more convex than that of the ventral. Breast naked. Straight portion of lateral line commencing well behind origin of soft dorsal and anal fins and shorter than curved portion; the bucklers are well-developed posteriorly, but not hooked forward. Dorsal and anal fins lobed anteriorly, without convex margins, produced rays, or finlets. No transverse bands across head or body.

Turrum emburyi, sp. nov.

(Plate xxxviii, fig. 4.)

Br.7. D.viii/i, 29; A.ii/i, 24; P.21; V.i/5; C.17. L.lat. scutes 40 or more on straight portion.

Head one-fourth of standard length, the upper profile steep and convexly rounded above. General form deep, compressed, the upper profile of the body more convex than the lower. Vent between ends of ventrals.

Eye rather small, more than 2 in preorbital and nearly 3 in snout. Maxillary not reaching level of eye. A band of villiform teeth in each jaw; others on vomer and palatines. Gill-rakers long, but not projecting into mouth, blunt-tipped, 15 on lower limb of first gill-arch. Pseudobranchiæ present.

Dorsal and anal fins long, without produced rays, and with the anterior rays only forming moderate lobes; both fins have low sheaths at their bases anteriorly. Pectoral falciform. Lateral line arched for the first half of its length, becoming straight below the soft dorsal fin; there are at least forty scutes on the straight portion; these are very small anteriorly, but occupy most of the sides of the caudal peduncle posteriorly. The breast is naked backward to behind the ventrals, but scales from the sides of the body encroach upon the naked area between the pectorals and ventrals.

General colour opalescent bluish above, with a few yellow spots on upper parts of sides, and light silvery below. Fins smoky olive. A small black opercular blotch and a broken line of dark brown marks along anal base. Pectoral axil black.

[31] Girard.—Péron sa Vie, 1857, p. 162.
[32] McCulloch.—Austr. Mus. Mem., v, 1929, pp. 413-414.

Described from the holotype, a large specimen, about 32 inches in total length, and weighing 13 pounds. This was one of a series, 7 to 16 pounds in weight, caught by fishermen at North-west Islet, Queensland, in May, 1931.

The vernacular name, "Turrum", applied to this fish has been utilized for its generic title, whilst the specific name has been given in honour of Mr. E. M. Embury, leader of an expedition, of which the writer was a member, to North-west Islet.

This species is a good sporting fish, being caught on spinners trolled from a launch. The flesh is reddish, and, when cooked, is firm and finely flavoured.

Family LUTJANIDÆ.

Genus **Glabrilutjanus** Fowler, 1931.

Glabrilutjanus marshalli, sp. nov.

D.x/17; A.iii/9; P.ii/15; V.i/5; C.15. L.lat. 54. L.tr.8/1/20.

Head (41 mm.) 2·8, depth (43·5) 2·6 in standard length (115). Eye (8) 5·1, interorbital (9) 4·5, and snout (16) 2·5 in head. Pectoral (25) 1·2 in height of second dorsal (30).

Head and body compressed. Eye rather small. Preoperculum finely denticulated, without notch. Maxillary not quite reaching vertical of eye. Upper lip deflected upwards. A canine on each side of symphysis of upper jaw. A narrow band of villiform teeth in each jaw and on palatines and in a boomerang-shaped patch on the vomer. Tip of tongue rounded. Seven or eight oblique scale-rows on cheeks. Opercles scaly; temples and top of head naked. Gill-membranes united to a narrow isthmus. Gill-rakers lanceolate above and rudimentary below; eleven or more on the first gill-arch.

Body deep, covered with moderate ctenoid scales which do not extend far on to the fins. The scale-rows are all subhorizontal or sloping downwards slightly posteriorly.

First dorsal fin low, with a convex margin, the fifth spine longest. Second dorsal elevated, higher than long, but not produced into filaments. Anal similar to second dorsal but lower; the spines increasing in length backward. Third and fourth pectoral rays longest, but not nearly as long as head. Ventrals about half as long as head and reaching the vent when adpressed. Caudal emarginate, shorter than pectoral.

General colour, in formalin, grey above and whiter below. Five whitish, subhorizontal stripes (probably blue in life) on the upper parts of the body; the first along base of spinous dorsal, the second parallel to it but lower, the third running from eye to end of soft dorsal and crossing the highest part of the lateral line, the fourth extending from shoulder to below termination of dorsal, and the fifth running from opercular point to middle of caudal peduncle. Some indistinct vertical fuscous areas extend from below the dorsal fins across the upper half of the sides, and the scales near the root of the tail are dark grey. Pectoral base dark grey, its axil whitish. Each body-scale with a dusky grey margin. Head whitish, becoming grey on the cheeks and brownish-grey on opercula and nape. A curved dark grey line crosses the interorbital, a U-shaped mark crosses the snout and joins the nostrils, and the tip of the snout and top of upper lip are dark grey. An indistinct smoky stripe below eye. Fins whitish with some greyish infuscations. Ventrals dark grey, as is also a distal band on the anal fin.

Mr. T. C. Marshall, of the Queensland Museum, after whom I have pleasure in naming this species, noted the colours of this fish, when fresh, as: "Belly rose-colour. Fins yellow. Body with bands of blue."

Described from the holotype of the species, a specimen 115 mm. in standard length or 5½ inches in total length. Queensland Museum Regd. No. I.4723.

Locality.—Dunwich, Moreton Bay, Queensland; caught by Mr. Dick Perry, March 2, 1931.

Mesoprion aurivittatus and *M. helenæ* Saville-Kent,[33] *nomina nuda*, may be relegated to the synonymy of *Glabrilutjanus marshalli.*

Family LETHRINIDÆ.

Genus Lethrinus Cuvier, 1829.

Lethrinus viridis, sp. nov.

Lethrinus flavescens Saville-Kent, Gt. Barr. Reef, 1893, p. 369. *Nom. nud. ex* De Vis MS. Queensland. *Id.* McCulloch, Austr. Mus. Mem., v, 1929, p. 227. Not *L. flavescens* Cuv. and Val., Hist. Nat. Poiss., vi, Sept., 1830, p. 299, from Tongatabu.

Lethrinus viridis, *lachrymans*, *margaritifer*, and *regius* Saville-Kent, Gt. Barr. Reef, 1893, p. 369. *Nomina nuda ex* De Vis MS. Queensland.

Lethrinus richardsonii Günther, Ann. Mag. Nat. Hist. (3) xx, 1867, p. 59 (Cape York rec. only). *Id.* Klunzinger, Sitzb. Akad. Wiss. Wien, lxxx, 1, 1879, p. 357 (Endeavour R. and Port Darwin). Not *L. richardsonii* Günther, Cat. Fish. Brit. Mus., i, 1859, p. 456, from China.

D.x/9; A.iii/8; L.lat. 48. L.tr.6/1/16.

Head (37·5 mm.) 2·7, depth (42·5) 2·4 in standard length (103). Orbit (12) greater than interorbital (9) and 1·5 in snout (18) or subequal to preorbital (11·5). Depth of caudal peduncle before tail-fin (13) nearly 8 in standard length.

Head longer than deep, its upper profile sloping obliquely, becoming gibbous on nape and very slightly convex before the eyes. Interorbital slightly convex, without median ridge. Lateral teeth conical; posterior teeth small and blunt, not molariform nor in several series.

Depth of body greater than length of head. Lateral line following the curve of the back, overlying three-quarters of the sides, and with five rows of scales above it.

Second dorsal spine not so long as third. Second anal spine equal to third; height of soft anal less than its length. Pectoral (30 mm.) less than head in length, but twice as long as ventral spine. Ventrals reaching base of first anal spine. Caudal markedly emarginate.

Colour now faded to a uniform yellowish-brown. Apparently no black lateral blotch or cross bands.

Described from the largest of seven small specimens from Cape York in the "old collection" of the Queensland Museum (Regd. No. I.6/84). These were labelled *L. flavescens*, but they do not belong to that species of which I have seen Melanesian specimens. Other labels bore some unpublished names of De Vis. I have selected for this novelty the name *L. viridis*, one of several *nomina nuda* listed

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[33] Saville-Kent.—Gt. Barrier Reef, 1893, p. 369. Queensland.

by Saville-Kent. I have been unable to find any specimens upon which he may have based the names *L. lachrymans*, *margaritifer*, and *regius*, so designate them synonyms of *viridis*.

The specimen described above agrees fairly well with *Lethrinus richardsonii* as described by Herre and Montalban,[34] but the maxillary does not reach to below the nostrils.

Family LABRIDÆ.

Genus Chœrodon Bleeker, 1847.

Chœrodon albigena (De Vis).

Chœrops albigena De Vis, Proc. Linn. Soc. N. S. Wales, ix, 4, March 4, 1885, p. 876. Cape York, Queensland. Type (No. I.110) in Queensland Museum seen.

Chœrops olivaceus De Vis, Proc. Linn. Soc. N. S. Wales, ix, 4, March 4, 1885, p. 876. [Dunk Island off] Cardwell and Cape York, Queensland. Lectotype (I.4734) in Qld. Mus. seen. Not *Cossyphus olivaceus* Dumont, Dict. Sci. Nat., xxix, 1823, p. 268.

Chœrops concolor De Vis, Proc. Linn. Soc. N. S. Wales, ix, 4, March 4, 1885, p. 876. North-east coast of Queensland. Type (I.946) in Qld. Mus. seen.

Chœrops unimaculatus De Vis, Proc. Linn. Soc. N. S. Wales, ix, 4, March 4, 1885, p. 877. Barrier Reef, Queensland. Types (I.95) in Qld. Mus. seen. Name preoccupied by *Chœrops unimaculatus* Cartier, Verh. Phys. Med. Ges. Würzburg, v, 1873, p. 102 (*fide* Fowler and Bean, Bull. U.S. Nat. Mus., 100, vii, 1928, p. 198).

Chœrodon albigena Ogilby, Mem. Qld. Mus., ii, 1913, p. 93. *Id.* McCulloch and Whitley, Mem. Qld. Mus., viii, 1925, p. 168.

Chœrodon olivaceus Ogilby, Mem. Qld Mus., ii, 1913, p. 93. *Id.* McCulloch and Whitley, Mem. Qld. Mus., viii, 1925, p. 168.. *Id.* Whitley, Austr. Zool., iv, 4, 1926, p. 231 (N.-W. Islet and Wide Bay, Q.). *Id.* Paradice and Whitley, Mem. Qld. Mus., ix, 1927, p. 92 (Pellew Group, Gulf of Carpentaria).

D.xiii/7; A.iii/10; P.i/15; V.i/5; C.12. L.lat. 28–29; L.tr.4/1/8–9.

Head (95 mm.) 2·6, depth (108·5) 2·3 in standard length (254). Eye (15) 6·3, preorbital (37) 2·5, snout (42) 2·2, interorbital (21·5) 4·4, eye to lower preopercular margin (47) 2 in head.

Head and body elevated, compressed. Upper anterior profile regularly convex. Eye small. Interorbital broadly convex. Spaced rudimentary scales on cheeks, a single row on suboperculum; large scales on operculum, rest of head naked. Preoperculum entire, the serræ having become obsolete. Vertex of head pitted; preorbital with radiating tubes. A broad, faintly striated opercular flap; lower margin of operculum deeply concave. Mouth just reaching vertical of anterior orbital margin. Two pairs of bluish tusks in each jaw, those of the lower being largest. Some small, stout canines near the tusks in upper jaw and at back of sides of lower jaw; dental ridges confluent laterally. Apparently no posterior canines. The gills of the type have been mutilated, so the gill-rakers may not be counted.

[34] Herre and Montalban.—Philip. Journ. Sci., xxxiii, 4, 1927, p. 405, pl. ii, fig. 2. Philippine Islands.

Body covered with large cycloid scales which are arborescent on the continuous lateral line, which has four rows of scales above it and eight or nine below. Scales on caudal root not much enlarged. Six predorsal scales.

Eleventh dorsal spine longest (22 mm.), shorter than the longest (sixth) dorsal ray (37 mm.). Pectoral (75 mm.) shorter than head. Ventrals reaching base of first anal spine. Caudal margin bisinuate, its upper lobe subequal to snout and a little longer than least depth of caudal peduncle.

Colour, after long preservation in formalin, now faded to uniform light brownish. A smoky blotch on snout and tip of lower jaw and on tip of upper caudal lobe may not be natural. De Vis noted the colours as "Violet brown, chin yellowish white; anal with four pale longitudinal bands. A dark blotch (sometimes obsolete) on the back beneath the ninth dorsal spine."

Described from the holotype of *Chœrops albigena* De Vis, a specimen 254 mm. in standard length or 11¼ inches in total length, collected by Kendall Broadbent at Cape York, Queensland.

The type of *Chœrops concolor* De Vis, also in the Queensland Museum, is a small skin, apparently referable to this species, with the preoperculum denticulated, the body more slender than in the adult and with the eye larger. It was collected by K. Broadbent in north-east Queensland.

The two paratypes of *Chœrops unimaculatus* De Vis from Cardwell also agree with this species. One has a black spot below the dorsal fin and the other has the lower caudal lobe with a brownish margin, perhaps a stain. These specimens have turned greenish in preservative.

The holotype of *Chœrops olivaceus* De Vis, from Dunk Island, off Cardwell, Queensland, agrees in practically all details with that of *albigena*, the only apparent differences being as follows:

Lateral line obliquely bent. Pores behind eye rather few. Ventrals reaching anal spine .... *albigena* (type).

Lateral line evenly curved. Pores behind eye numerous. Ventrals not reaching anal spine ...... *olivaceus* (type), also types of *concolor* and *unimaculatus*.

These differences may perhaps be accounted for by changes with growth and age, or may indicate that there is a northern (*Chœrodon albigena albigena*) and a southern (*Chœrodon albigena olivaceus*) form of this species, a condition comparable with that of *Pseudopomacentrus wardi wardi* and *P. wardi macleayi*, in the Family Pomacentridæ, as demonstrated in my paper on the fishes of Low Isles, Queensland (in the press).

Other specimens of *Chœrodon albigena* are preserved in the Queensland Museum, labelled "*Chœrodon olivaceus* De Vis. Magnetic Island, coll. Taylor" (No.I.1780) and "*Chœrops cyanodon* Rich. Queensland coast. coll.?"

The Australian Museum has specimens from Vanderlin Island, Pellew Group, Gulf of Carpentaria; Great Sandy Strait, Wide Bay, and North-west Islet, Queensland. There is also an old specimen labelled "Port Jackson", but the locality may be doubted. *Chœrodon albigena* is not authentically known outside Queensland waters at present.

Chœrodon venustus (De Vis).

Chœrops venustus De Vis, Proc. Roy. Soc. Qld., i (about July), 1885, p. 147. Moreton Bay, Queensland. Type (old. coll. No. 4735) in Queensland Museum seen.

Chœrodon venustus Cockerell, Mem. Qld. Mus. ii, 1913, p. 58 (scales). *Id.* Ogilby, Mem. Qld. Mus., ii, 1913, p. 93. *Id.* McCulloch, Austr. Zool., ii, 1922, p. 98, fig. 264*a* (Clarence and Richmond Rivers, N. S. Wales). *Id.* Whitley, Austr. Zool., iv, 1926, p. 232 (Queensland locs.).

The type of this species differs at sight from *C. albigena* in having a slight dip in profile before the eyes, preoperculum very finely denticulate, and eye large. Roughley[35] has figured a New South Wales specimen as *C. ommopterus* Richardson, with which species it has been confused by some authors (*vide* Ogilby, *loc. cit.*, 1913).

Chœrodon vitta Ogilby.

Chœrodon vitta Ogilby, Proc. Roy. Soc. Qld., xxiii, Nov., 1910, p. 13; Ann. Rept. Amat. Fish. Assoc. Qld., 1910–11, July, 1911, p. 11. Dobo, Aru Islands. Lectotype (I.1555) in Queensland Museum seen, also a paratype in A.F.A.Q. Museum, Brisbane, and another in Austr. Mus., Sydney.

This species is quite different from the foregoing and possibly deserving of subgeneric distinction, as the lateral tusks in the lower jaw are flared upwards and outwards. Pectorals evenly rounded. Ventrals not reaching anal fin. An indistinct oblique band below eye. A large brown blotch on caudal peduncle. Not authentically known from Australia.

Chœrodon lineatus (De Vis).

Torresia lineata De Vis, Proc. Linn. Soc. N. S. Wales, ix, 4, March 4, 1885, p. 881. Cardwell, Queensland. Type (No. I.82) in Queensland Museum seen.

Chœrodon ambiguus Ogilby, New Fish. Qld. Coast, Dec., 1910, p. 100. Off Double Island Point, south Queensland; 33 fathoms. Type (No. I.1543) in Queensland Museum seen. A co-type in the Austr. Mus. figured by Whitley, Rec. Austr. Mus., xvii, 1929, p. 125, pl. xxxiii, fig. 4.

Chœrodon lineatus and *C. ambiguus* McCulloch and Whitley, Mem. Qld. Mus., viii, 1925, p. 168.

The holotype of *Chœrodon ambiguus* Ogilby "Deposited by the A.F.A.Q." in the Queensland Museum, but actually collected by the F.I.V. "Endeavour", is now soft and partly decayed. It agrees with my figure, quoted above, and has rudimentary scales on cheeks in regular rows, but scarcely imbricate. Most of head pitted with regularly spaced pores. On left side of head are two dark marks just above and behind eye. Five predorsal scales. There is no doubt that this species is synonymous with *Torresia lineata* De Vis, the type of which, collected by Broadbent, is also now partly decayed, but has the characteristic "pimply" head. The lower canines are not flared outwards.

Chœrodon anchorago (Bloch).

Sparus anchorago Bloçh, Nat. ausl. Fische, v, 1791, p. 108, pl. cclxxvi. No loc. Received from the Holland auction.

Labrus macrodontus Lacépède, Hist. Nat. Poiss., iii, 1802, pp. 451 and 522. No loc. From collection ceded to France by Holland.

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[35] Roughley.—Fish. Austr., 1916, p. 150, pl. 50.

Labrus chlorodus Gray, Cat. Fish. Coll. Gronow Brit. Mus., 1854, p. 80. *Ex* Gronow MS. No loc. Seen at Hague in D. van Hoey coll. This may even be the same specimen as named by Bloch and Lacépède.

Chœrops macrodon Bleeker, Atl. Ichth., i, 1862, p. 162, pl. xlvii, fig. 1. *Id.* Günther, Cat. Fish. Brit. Mus., iv, 1862, pp. 94 and 505.

Labrus choirodon Bleeker, Atl. Ichth., i, 1862, p. 162. *Ex* Kuhl and van Hasselt MS. No loc. Name in synonymy only.

Chœrops graphicus De Vis, Proc. Linn. Soc. N. S. Wales, ix, 1885, p. 878. Cardwell, Queensland. Type (I.944) in Queensland Museum.

Chœrodon weberi Ogilby, Ann. Rept. Amat. Fish. Assoc. Qld., 1910-11, July, 1911, p. 11. *Nom. nud. Id.* Ogilby, Ann. Qld. Mus., x, Nov. 1, 1911, p. 52. Dobo, Aru Is. Type (I.1532) in Queensland Museum seen.

D.xiii/7; A.iii/9; P.i/14; V.i/5; C.12. L.lat. 29. L.tr.4/1/9.

Head (62 mm.) 2·6, depth (60) 2·7 in length to hypural joint (163). Eye 11 mm., preorbital 22·5, snout 27, interorbital 16, distance from eye to lower preopercular margin 27, least depth of caudal peduncle 25·5.

Form robust. Upper anterior profile convex, slightly tumid over eyes. Interorbital broadly convex. Eyes moderate. About nine oblique rows of imbricate scales on cheeks; a row of larger ones on suboperculum with a few rudimentary scales forming a second row; large weak scales on operculum, rest of head naked and smooth. Preopercle entire with obsolescent serræ. A broad, weakly striated opercular flap with an excavate lower margin. Maxilla not reaching vertical of eye. Tusks white or very faded bluish. Two large inner and two small outer tusks in upper jaw; outer tusks of lower jaw longest and curved outwards as in *Chœrodon vitta.* Lateral teeth confluent into ridges, but almost separate at back of mandible. Posterior canines well developed. Gill-rakers short, curved, pointed, 6 + 10 on first gill-arch.

Body-scales cycloid, with broad membranous margins. They lie in three series above the arborescent lateral line, not counting the smaller scales along the base of the dorsal fins. About seven predorsal scales.

Dorsal spines longest posteriorly, the last measuring 13 mm. from the scaly base. Penultimate dorsal ray (22 mm.) longest and equal to seventh and eighth anal rays. Pectoral (45) with convex margin. Ventrals (38) not reaching anal fin. Caudal margin broadly convex, its rays shorter than those of the ventrals.

Colour, after long preservation in formalin, dark brown. Sides of head with small white spots which are much smaller than the interspaces. A light vertical bar below seventh and eighth scales of lateral line and fading into the body-colour behind the pectoral fin. A light saddle-shaped area embraces nearly all the upper half of the caudal peduncle. Base and axil of pectoral blackish. Some small and inconspicuous pearly spots on nape and on some of the scales on the back. Dorsal fin smoky, especially over the darkest portion of the body-colour, which is on the posterior half of the back. A narrow light margin along the tops of the soft dorsal and anal fins. Caudal membranes dusky proximally. Pectorals and ventrals whitish.

Described from the lectotype of *Chœrodon weberi* Ogilby, a specimen 163 mm. in length to hypural joint, or nearly eight inches in total length. Collected by John Colclough, a brother of the last Queensland Museum taxidermist, at Dobo,

Aru Islands. It agrees better with Bleeker's figure in the Atlas Ichthyologique than with Bloch's original plate, and differs from *Chœrodon melanostigma* Fowler and Bean[36] in having the anterior profile not so far removed from front of eye and in different coloration.

I have much pleasure in expressing my indebtedness to Mr. H. A. Longman, Director of the Queensland Museum, and to Mr. T. C. Marshall, of the same institution, for placing their collection of *Chœrodon* spp. at my disposal on my visit to Brisbane last May. The synonymy detailed above is a step towards an understanding of the Australian species, but considerable work has yet to be done before our knowledge of even the forms already described can be regarded as in any way complete.

Family SILLAGINIDÆ.

Genus Sillago Cuvier, 1816.

Sillago ciliata diadoi Thiollière.

Sillago ciliata Cuvier and Valenciennes, Hist. Nat. Poiss., iii, April, 1829, p. 415. "Southern Seas" (Péron). Type-loc. King George's Sound, W. Australia, designated by Fowler, Mem. Bish. Mus., x, 1928, p. 235, but Péron's specimen may have come from Tasmania or even Sydney.

Sillago diadoi Thiollière, Ann. Soc. Imp. Agric. Hist. Nat. Lyons, viii, 1856, p. 351; Essai Faune Woodlark, 1857, p. 151. Woodlark I. Based on a drawing by Montrouzier, labelled *Merlucius?*.

Sillago insularis Castelnau, Proc. Zool. Acclim. Soc. Vict., ii, May 10, 1873, p. 114. Noumea, New Caledonia.

Sillago terræ-reginæ Castelnau, Proc. Linn. Soc. N. S. Wales, ii, 3, May, 1878, p. 232. Moreton Bay, Queensland.

Sillago auricomis Ogilby, New Fish. Qld. Coast, Dec. 20, 1910, p. 97. Coast of southern Queensland; 437 specimens from various locs.

Br.5. D.xi/i,17(18); A.ii/16; P.i/15; V.i/5; C.15. L.lat. 62 to hypural (+ 3 and some minute caudal scales). L.tr.6/1/12.

Head (100 mm) 3·32; depth (72) 4·6 in standard length (332). Eye (18) 5·5 in head. Interorbital (30) 1·4 in snout (42), which is longer than postorbital portion of head (37).

Head naked except for two or three rows of scales on the cheeks, others on operculum, and those on the top of the head extending backward from the interorbital. A band of villiform teeth, largest anteriorly, on each side of both upper and lower jaws; no teeth on symphyses. A band of villiform teeth on vomer; none on palatines. Pharyngeal teeth molariform. A flat opercular spine. Pseudobranchiæ present. Eight gill-rakers on lower limb of first arch; short and pointed above, rudimentary and granulose below.

Form of body rather robust, covered with large, regular, ciliated scales which extend over the caudal root and become minute on the caudal membranes. Breast flat, scaly. First dorsal originating behind the insertion of the pectorals and ventrals, separated by one or two scales from the second dorsal, whose base (97 mm.) is longer than that of the anal (85). Second dorsal spine (60) longest, nearly twice as long as the longest (first) ray (31). Rows of scales on membranes

[36] Fowler and Bean.—Bull. U.S. Nat. Mus., 100, vii, 1928, p. 199, pl. xvi. Jolo, Philippine Islands. Types in U.S. Nat. Mus.

between spines and rays of both dorsal and anal fins. Anal similar to second dorsal, its origin beneath the second dorsal ray. Second anal ray (29 mm.) longest. Three scales between urinogenital apertures and first anal spine. Pectoral rounded, its fourth ray (55 mm.) longest, greater than the first ventral ray (50). Caudal forked, the upper lobe (60) longer and more pointed than the lower (50), which has a rounded margin.

General colour olivaceous on the back, shading to white on the belly, the tone darkest on the dorsal fins and tail and becoming greenish-grey on the top of the snout. Iris golden, with some brown above and whiter below; pupil black, surrounded by a yellowish ring. A large dark grey patch covers the pectoral base; inner axil tinged with wine colour. Dorsal fins olive-greenish with smoky markings forming spots between the rays and spines. Pectorals, ventrals and anal light yellowish. Caudal dark olivaceous with a narrow grey margin. A small dark grey spot before each ventral fin.

Three Cymothoid parasites at back of mouth and one on the pharyngeal teeth.

Described from a large adult male specimen, 332 mm. in standard length, or 15½ inches in total length. Netted close to the shore of North-west Islet, Queensland, where it was swimming slowly over a sandy bottom, by the writer, May 26, 1931.

I identify this species as *Sillago ciliata diadoi* as Thiollière's name appears to be the earliest which may be applied to the Queensland species. The type-locality of *S. ciliata* Cuv. and Val. is doubtful, but as Péron did not collect in what is now Queensland, it is extremely improbable whether Cuvier and Valenciennes' name can be used for this north-eastern Australian form. *Sillago insularis*, *terræ-reginæ*, and *auricomis* are evidently synonyms of *S. ciliata diadoi*.

Family RHOMBOSOLEIDÆ.

Genus **Ammotretis** Günther, 1862.

Ammotretis Günther, Cat. Fish. Brit. Mus., iv, 1862, p. 458. Haplotype, *A. rostratus* Günther.

Tapirisolea Ramsay, Internat. Fisher. Exhib., Cat. Exhib. N. S. Wales Court, 1883, pp. 17 and 44. *Nomen nudum.*

Ramsay's name may be designated a synonym of *Ammotretis*, as I have not been able to find a description of *Tapirisolea* in either the published work of Ramsay or in any of his manuscripts available to me.

Ammotretis rostratus Günther.

Ammotretis rostratus Günther, Cat. Fish. Brit. Mus., iv, 1862, p. 458. Norfolk Bay [Tasmania]. Type in British Museum. *Id.* Norman, Biol. Res. Endeav., v, 5, 1926, p. 267 (refs., etc.).

Ammotretis ovalis Saville-Kent, Prelim. Rept. Food-Fish. Qld., 1889, p. 10; Great Barrier Reef, 1893, p. 370. *Nomen nudum* [*ex* De Vis MS.]. "Queensland" [= South Australia].

Through the courtesy of Mr. H. A. Longman, Director of the Queensland Museum, I have been permitted to examine a volume of manuscripts, written in the 'eighties of last century by C. W. De Vis. This is one of a series of exercise-books

in that institution, and includes descriptions of fishes, measurements of fossils, and other items. Here and there a new bird or reptile is described and many new names are proposed in MSS. Some of these have been crossed out when De Vis realized they were synonyms of published names. This manuscript was utilized by Saville-Kent in the preparation of his book on the Great Barrier Reef of Australia, and it is unfortunate that, in this way, a list of *nomina nuda*, which are only gradually being disposed of, came into being. This list, which was first issued in 1889 in a Parliamentary Report, includes, as one of the food-fishes of Queensland, *Ammotretis ovalis*, but inspection of De Vis' MS. description shows that this species was originally received from South Australia, not Queensland, where the genus is not known to occur. The name *Ammotretis ovalis* Saville-Kent may now be disposed of as a synonym of *Ammotretis rostratus* Günther.

In the family Soleidæ, it would be convenient to relegate *Synaptura armata* and *S. inermis* Saville-Kent, *nomina nuda*, to the synonymy of *S. cinerea* De Vis 1883 = *S. nigra* Macleay 1880.

Family SYNANCEJIDÆ.

Dampierosa, gen. nov.

Orthotype, *Dampierosa daruma*, sp. nov.

Near the genus *Erosa* of authors (? *Erosa* Swainson, 1839), but distinguished by having the upper profile of the head convex, the body papillated, and fewer dorsal spines and pectoral rays.

Dampierosa daruma, sp. nov.

(Plate xxxviii, figs. 2 and 3.)

D.xii/i,9; A.ii/7; P.12; V.i/4; C.12.

Head, measured obliquely from symphysis of upper jaw to end of opercular flap (46 mm.), subequal to depth (47) and to distance from origin of dorsal to snout (45) and rather more than 2 in length to hypural joint (98). Eye (10) 2·5 in interorbital (25) or 4·6 in head. Third (longest) dorsal spine (13) equal to depth of caudal peduncle (13). Last dorsal spine (10) 1·7 in sixth (longest) dorsal ray (17). Fourth (longest) pectoral ray (26·5) considerably longer than ventral (21·5).

Head bulbous, its upper profile broadly convex, but the surface very irregular owing to the numerous corrugations formed by the underlying bones. Top of head cavernous, except at the transverse interorbital ridge. Preorbital and preoperculum armed with prominent blunt spines. Occipital spines blunt and almost confluent, forming a bony ridge on each side of the nape. No pit on cheek. Preopercular stay coarsely striated from a median eminence. A prominent knob at the base of the operculum. No barbels or wart-like outgrowths on head. Mouth oblique, with an almost semicircular opening, the broad maxillary reaching to below the middle of the eye. Tongue large, rounded. Bands of villiform teeth on jaws, separated at the symphyses. A boomerang-shaped patch of teeth on the vomer; palatines toothless. No prominent knob at symphysis of the lower jaw, which fits into a slight depression in the upper jaw. Gill-slits wide, separated at the isthmus by 15 mm. Four branchial arches, no slit behind fourth. Seven or eight short, rounded, thick gill-rakers on first arch. Pseudobranchiæ present. Anterior nostrils tubular; posterior ones pore-like.

Form of body deep and robust anteriorly, compressed and rather tapering posteriorly. Body scaleless, covered with small papillæ and with blunt spine-like outgrowths on the nape and parts of the flanks. Lateral line with about ten pores, indistinct posteriorly, but with blunt spine-like processes anteriorly. Body and fins covered with a thick layer of mucus.

Dorsal fin originating over hinder half of head well behind the eye and terminating behind the vertical of the anal base and a little in advance of the caudal. Thirteen rather low weak dorsal spines, the first three of which are highest and broadly webbed, but none of the spines is as long as the dorsal rays. Anal commencing below end of spinous dorsal. Pectorals short, not reaching anal, broad, the upper rays slender and branched and the lower ones shorter and thickened into curved fingers; no free fin-rays. Ventrals short, each with a blunt spine and four rays, the last of which is much shorter than the others. Caudal rounded, all its functional rays branched.

General colour in alcohol dark purplish-brown, irregular in tone and broken up by the lighter papillæ and raised cephalic surfaces. Interorbital and pterotic regions white. Light brown mottling on lower surface of head and on parts of the body below the spinous and soft dorsal fins. Dorsal dark brown anteriorly, but mottled yellowish on the middle and posterior spines. Soft dorsal dark brownish with a narrow margin of yellow and a broad oblique median band of yellow. Anal similar to soft dorsal. Pectoral dark brownish with a yellowish band partly encircling its base, a broader band crossing the rays to form large ocelli below, and a distal margin of yellowish. Ventrals dark brown with two bands of yellowish and a similarly coloured spot on the proximal part of the last ray. Caudal dark brown, crossed by a broad median band of yellowish and with a broad margin of the same colour.

Easily distinguished from the species of "*Erosa*" by the more even profile of the head, fewer dorsal spines and pectoral rays, and different coloration.

Described and figured from the unique holotype of *Dampierosa daruma*, a specimen 98 mm. in standard length, or nearly five inches in total length. Dredged off Broome, north-western Australia, in 1931, by Mr. R. Bourne.

Australian Museum registered No. IA.5116.

Family OPHICLINIDÆ.

Genus **Ophiclinus** Castelnau, 1872.

The species of this genus were reviewed by McCulloch and Waite,[37] but those authors were apparently unaware that Herzenstein[38] had previously described two species of *Neogunnellus* (= *Ophiclinus*) from Saint Vincent's Gulf, South Australia. I am indebted to Professor P. Schmidt, of Leningrad, for copies of Herzenstein's descriptions of these species, *N. homacanthus* and *N. microchirus*. Fortunately, these names do not clash with those of McCulloch and Waite, as *microchirus* seems to be a "good" species, having D.90; A.56, and *homacanthus* a close ally of *Ophiclinus antarcticus* Castelnau.

[37] McCulloch and Waite.—Rec. S. Austr. Mus., i, 1, May 24, 1918, pp. 54-59, and figs.

[38] Herzenstein.—Ann. Mus. Zool. St. Petersburg, i, 1896, pp. 5 (*homacanthus*) and 7 (*microchirus*).

Ophiclinops, gen. nov.

Orthotype, *Ophiclinus pardalis* McCulloch and Waite[39] = *Ophiclinops pardalis*.

Differs from true *Ophiclinus* in having the head comparatively smaller and the body more elongate. Bands of obtusely conical teeth on jaws and vomer. Lateral line obsolete. Dorsal commencing well behind head, with more than 50 spines and a single ray. Anal with two spines and 39 rays. Dorsal and anal completely connected to caudal by membrane. Pectorals reduced, smaller than eye.

EXPLANATION OF PLATES.

Plate XXXVI.

Fig. 1.—*Hemiscyllium ocellatum* (Bonnaterre). A specimen from Low Isles, Queensland. *a*, lateral view; *b*, ventral surface of head; *c*, teeth; *d*, dermal denticles; *e*, a denticle much enlarged.

Fig. 2.—*Hemiscyllium trispeculare* Richardson. A specimen from Port Darwin, North Australia. *a*, lateral view; *b*, ventral surface of head; *c*, teeth; *d*, dermal denticles; *e*, a denticle much enlarged.

Plate XXXVII.

Figs. 1-3.—*Dæmomanta alfredi* (Stead). Three views of a specimen from off Cape Hawke, New South Wales.

Fig. 4.—*Dæmomanta alfredi* (Stead). Holotype from Port Jackson, New South Wales, with the late Gerard Krefft standing alongside.

Plate XXXVIII.

Fig. 1.—*Atelomycterus marmoratus* (Raffles). A specimen from Port Darwin, North Australia. *a*, lateral view; *b*, ventral surface of head; *c*, part of pattern on dorsal surface of body.

Fig. 2.—*Dampierosa daruma* Whitley. Holotype from off Broome, Western Australia.

Fig. 3.—*Dampierosa daruma* Whitley. Front view of head of type.

Fig. 4.—*Turrum emburyi* Whitley. A specimen from North-west Islet, Queensland.

Plate XXXIX.

Fig. 1.—*Uropterygius obesus* Whitley. Holotype from off Montague Island, New South Wales.

Fig. 2.—*Gymnothorax cribroris* Whitley. Holotype from North-west Islet, Queensland.

Fig. 3.—*Branchiostegus wardi* Whitley. Holotype from off Port Stephens, New South Wales.

[39] McCulloch and Waite.—Rec. S. Austr. Mus., i, 1, May, 24, 1918, p. 58, pl. iv, fig. 2. Streaky Bay, Great Australian Bight. Holotype in South Australian Museum. This species was omitted through inadvertence from McCulloch's Check-List: Austr. Mus. Mem., v, 1929, p. 352.

A NEW SPECIES OF FAT-TAILED MARSUPIAL MOUSE, AND THE STATUS OF *ANTECHINUS FROGGATTI* RAMSAY.

By

ELLIS LE G. TROUGHTON,
Zoologist, Australian Museum.

(Figure 1.)

A review of the extensive collection of *Sminthopsis* in the Australian Museum in 1929, revealed a wide range of variation in the structure of the pads of both manus and pes in specimens hitherto allocated to the fat-tailed species, *Sm. crassicaudatus*. These pads become so shrunken and distorted by drying that spirit series are essential, and there is no doubt that lack of such material has resulted in far too great a range being accorded to individual species in the past.

In his remarkable Catalogue of 1888 Thomas gave the range of *crassicaudatus* as the "Whole of Australia (not yet recorded from the extreme north)", and included Ramsay's *Antechinus froggatti* from Derby, N.W. Australia, in the synonymy of that species. Examination of Ramsay's holotype, however, provides characters warranting the distinction of the Derby form, and it is proposed later on to deal with several races occurring in eastern Australia, as indicated by the Museum material.

During the review, a most interesting fat-tailed specimen was discovered amongst the "old collection" from King George's Sound, Western Australia, which possesses characters markedly differentiating it from the true *crassicaudatus*, and warranting description as a new species. The pads of both manus and pes appeared to agree somewhat with those of the unfigured *Sm. hirtipes* from Central Australia, but my recent examination of the holotype in the British Museum showed them to be quite different.

In his "Mammals of South Australia" in 1923, Wood Jones remarked upon the usefulness of these little animals, and that havoc by insect pests would be considerably lessened if the *Sminthopsis* were not preyed upon by domestic cats. It is therefore interesting to note that the type of *crassicaudatus*, described by Gould in 1844, and obtained by his collector, Gilbert, while at the military station on the William's River, south Western Australia, "was brought into the station by a domestic cat, which is constantly in the habit of going into the bush and returning several times during the night with a small mammal or bird in her mouth". When the present writer collected in this region in 1921 wild cats were very numerous and it is most regrettable to think of the serious wastage of the fauna which has gone on since the earliest days of settlement. It is hoped that residents in this interesting faunal area may be encouraged to conserve any

small mammals brought in by cats so that injured ones may be preserved and possibly interesting material brought to light.

My best thanks are due to the Committee of the Macleay Museum for permission to examine Ramsay's type, kindly made available by the Curator, Mr. John Shewan, and to Miss Joyce K. Allan, who provided the very helpful illustrations.

Sminthopsis granulipes, sp. nov.

(Fig. 1.)

Diagnosis.—Head and body, and tail, of similar dimensions to *Sm. crassicaudatus*, but the skull decidedly larger and heavier; readily distinguished externally by the shorter, much broader and differently shaped ear, which lacks the conspicuous black patch externally, the shorter hindfoot, and the structure and much finer granulation of the pads of both manus and pes. The tail is whitish instead of greyish-blue, and sparsely though evenly covered with whitish hairs instead of the close-set brownish and buffy bristles of *crassicaudatus*.

Colour.—The holotype female, old spirit specimen, doubtless considerably faded: general tone of back mottled rusty-buffy, composed of the light buff ends and tawny tipping of the fur, through which the dark greyish-brown (Ridgway) of the basal colouring appears; the tawny tips form a rusty wash from the crown to the tail-root, and on the upper sides of the body, and a faint line from front of eye to ear-base. Centre of snout, cheeks, and entire undersurface of a clear pale

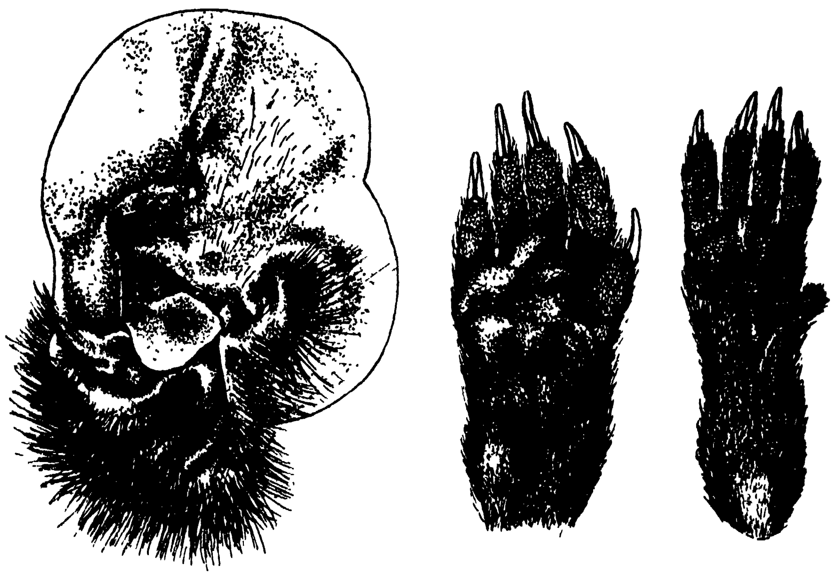


FIGURE 1.
The ear, manus, and pes of *Sminthopsis granulipes* sp. nov. The breadth of the supratragus, and marked convexity of the hind margin of the ear, with a decided notch above, are shown. The apices of the pads of both manus and pes lack the enlarged granules or smooth areas of other forms, and are not hirsute as in *Sm. hirtipes*.

olive buff, the fur below definitely bicoloured, the basal fur as dark as that of the back. The ear conch lacks the dark, closely haired and strongly contrasting anterior band characteristic of *crassicaudatus*. The manus and pes above, and the tail are buffy white, the tail covered with white, longish, soft hairs which are sparser and quite different to the closely set crisp bristles of the *crassicaudatus* tail.

External characters.—Fur of back long, about 10 mm., interspersed with stronger piles up to 15 mm. in length. Ear shorter, and much broader than in *crassicaudatus*, not surpassing the centre of the eye when laid forward, the greater breadth due to the marked convexity of the outer lower third of the conch. Inner margin more boldly convex to the tip, which is more evenly and broadly rounded; outer margin with a pronounced notch just below the upper third, which is accentuated by the bold convexity of the lower two-thirds. Supratragus very broad, its breadth equal to the greatest length anteriorly; not noticeably folded, but the hinder margin bent up owing to its arising from near the centre of the narrower basal part.

Pads of manus and pes very finely and evenly granulated, not surmounted by enlarged granules or smooth areas as in *crassicaudatus*, or covered with hairs as in *Sm. hirtipes*. The palmar area much elevated and consisting of a series of convolutions, divided by shallow wrinkles which do not isolate definite pads. There is no outer ulnar pad, with a smooth elongated crown, as in *crassicaudatus*, its place being taken by a low evenly granulated area not forming a pad. Pes with the central pad smaller, more elevated, and the apex more acutely pointed, and not differentiated from the two outer pads by deep grooves; foot completely haired from the heel to within 1 mm. of the hallux. Rhinarium much as in *crassicaudatus*, except that the concave margin below the nostril is more deeply emarginate, the rami of the philtrum being therefore more elongated. Tail definitely incrassated, though not as bulbous as in *crassicaudatus*. Mammæ five on one side, six on the other, probably twelve normally, as there are traces of a twelfth teat.

Palate-ridges.—There are ten undivided ridges, inclusive of the inter-incisor one and the hindmost which borders the palate, the series differing markedly in appearance from those of *crassicaudatus* and *froggatti* both in the general coarseness of the ridges and the tubercles between them, and in the acute triangularity of the inter-canine, and the possession of pronounced tubercles near the inner cusp of m^4.

Skull and teeth.—Skull much larger and heavier than in *crassicaudatus*, the nasals squared off posteriorly at their greatest width, instead of tapering. Upper first incisors obtusely rounded off and not exceeding the others in length, differing markedly from those of *crassicaudatus*, which are slender, cylindrical, and twice as high as the others. Upper tooth row longer, but molars not noticeably wider than in *crassicaudatus*, the outer cusps less tubercular, and more blade-like, and m^4 smaller and simpler in structure.

Dimensions of holotype.—In spirit: head and body, 87; tail, 55; hindfoot, 13·5; ear, length from outer base 17·5, greatest width 15·5.

Skull: Greatest length, to back of occipital crest, 27·3; zygomatic breadth, 15·2; nasals, 10 × 2·3; interorbital width, 5·5; breadth of brain-case, 11·7; palate, length 15·6, ant. foramina 3·4; upper tooth row 14·1, lower 13; $molars^{1-3}$, 4·9 mm.

Holotype.—Adult female, Palmer's register No. 669 in the "old collection" of the Australian Museum.

Locality.—King George's Sound, south Western Australia.

Remarks.—The holotype, old spirit specimen, is entered in the earliest Australian Museum register as "Coll. George Masters 1869 ?" and it is remarkable that the striking features did not lead to earlier description. In the handwriting of the original entry is written a specific name which indicated that it was regarded as new and that as a fresh specimen the white coloration of the hair of the tail, and possibly skin, was a remarkable feature.

As additional material, however, has often proved coloration to be variable, it was considered preferable to afford a name indicative of the unusually fine and rasp-like granulations of the paw-pads, which contrast markedly with the larger grain-like ones of *crassicaudatus*.

Sminthopsis froggatti Ramsay.

Antechinus (*Podabrus*) *froggatti* Ramsay, Proc. Linn. Soc. N. S. Wales (2), ii, 1887, p. 552.

Sminthopsis crassicaudata Thomas, *nec* Gould, Cat. Mars. Monotr. Brit. Mus., 1888, p. 306, pl. xxiii, fig. 8.

Diagnosis.—Of similar total length to *crassicaudatus*, but with a much longer tail and correspondingly shorter and more slender body, shorter hindfoot, and much smaller ear; fur of undersurface not bicoloured, whitish from base to tips.

Colour.—Holotype female, dried from spirit: general colour of back reminiscent of that of *Mus musculus*, the tone about dark grizzled olive brown, being a mixture of the warm buff and dark mummy brown tips; basal fur of back deep neutral grey. Dark pencilling of back continuing over the crown and down the centre of the snout. Cheeks and sides of the limbs clearer, about buffy grey. There is a light patch about the base of the ear, which lacks a heavy dark mark on its anterior margin. Fur of undersurface not bicoloured, but yellowish-white from base to tips, about ivory yellow in tone, contrasting strongly with the upper surface. Manus and pes buffy white. Tail, above similar to back, buffy white underneath.

External characters.—Fur of back shorter and sparser than in *crassicaudatus*, about 6·5 mm., interspersed with longer piles of about 8 mm. Manus and pes much more delicate but pads similar, excepting that the enlarged granules of the central areas are relatively much larger, especially on the pes, where they form a crest antero-posteriorly along the apex of the three pads. Naked line on centre of pes extending back, as in *crassicaudatus*, to about proximal third of sole, which is completely haired to the heel. Ear much smaller, laid forward it only reaches middle of eye, instead of well beyond; its outline as in the allied species, but hind margin less broadly convex, and the anterior border lacks the heavy dark band or hairing. Supratragus small, considerably twisted owing to the hind margin arising at the centre of its base. Tail much longer and more tapered than in *crassicaudatus*, the definite incrassation being nearer the root. Mammæ 8.

Palate-ridges.—Much as in *crassicaudatus*, nine counting the inter-incisor one, the interspaces seemingly more granular. Inter-canine ridge evenly arched as in *crassicaudatus*, not acutely triangular as in *granulipes*; minute tubercles at inner corners of m^4 much less pronounced.

Skull and teeth.—Skull relatively smaller and lighter than in *crassicaudatus*, and the nasals shorter but broader, and less tapered posteriorly; anterior palatal vacuities shorter. Incisors much as in *crassicaudatus*, but size of premolars not increasing so evenly, pm^1 three-fourths the size of pm^3 and both conspicuously smaller than pm^4; m^4 relatively broad and of similar structure.

Dimensions of holotype.—In spirit: head and body 73·5; tail 71; hindfoot 14; ear, from outer base 14, greatest width 9·5.

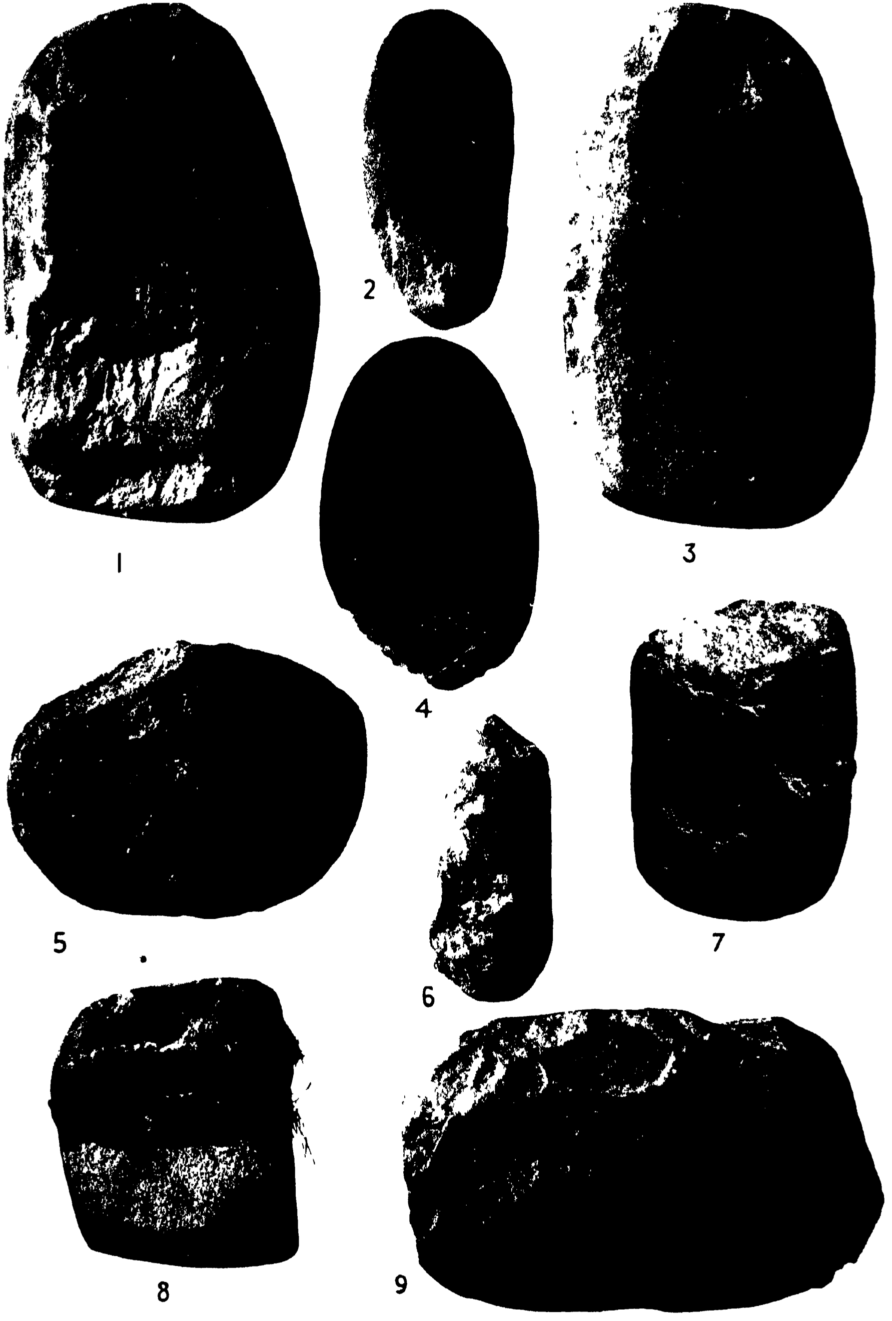
Skull: basal length, 21·3; zygomatic breadth, c12·5; nasals, 8·3 × 2·5; interorbital width, 4; breadth of brain-case, c10; palate, length 11·6, ant. foramina 2·8; upper tooth row 11·2, lower 10·3; $molars^{1-4}$, 4·5 mm.

Holotype.—Adult female in the Macleay Museum at the University of Sydney; collected by Mr. W. W. Froggatt, F.L.S., F.R.Z.S., when he was zoological collector for the Hon. William Macleay.

Habitat.—Found under debris near the beach in the "dindan" scrub bordering King Sound, near Derby, north Western Australia

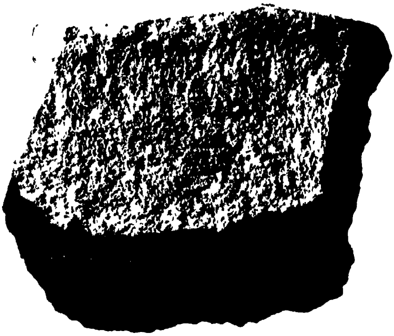
Remarks.—This species was sunk in the synonymy of *crassicaudatus* by Thomas within a year of its description, the outcome of the prevalent exaggerated conception of the range of the smaller Australian mammals.

Although Ramsay's description was rather indefinite, the decision was not justified, as the dimensions given conflicted with the type of *crassicaudatus*, the only correctly localized Western Australian specimen available to Thomas; he might also have considered the different faunal conditions of *froggatti*, about a thousand miles to the north. Examination of the holotype having removed all doubt as to its distinction, it is pleasing to record that a species with such interesting personal associations is now restored to the list of valid marsupial forms



G. C. CLUTTON, photo.

PLATE XXVIII.



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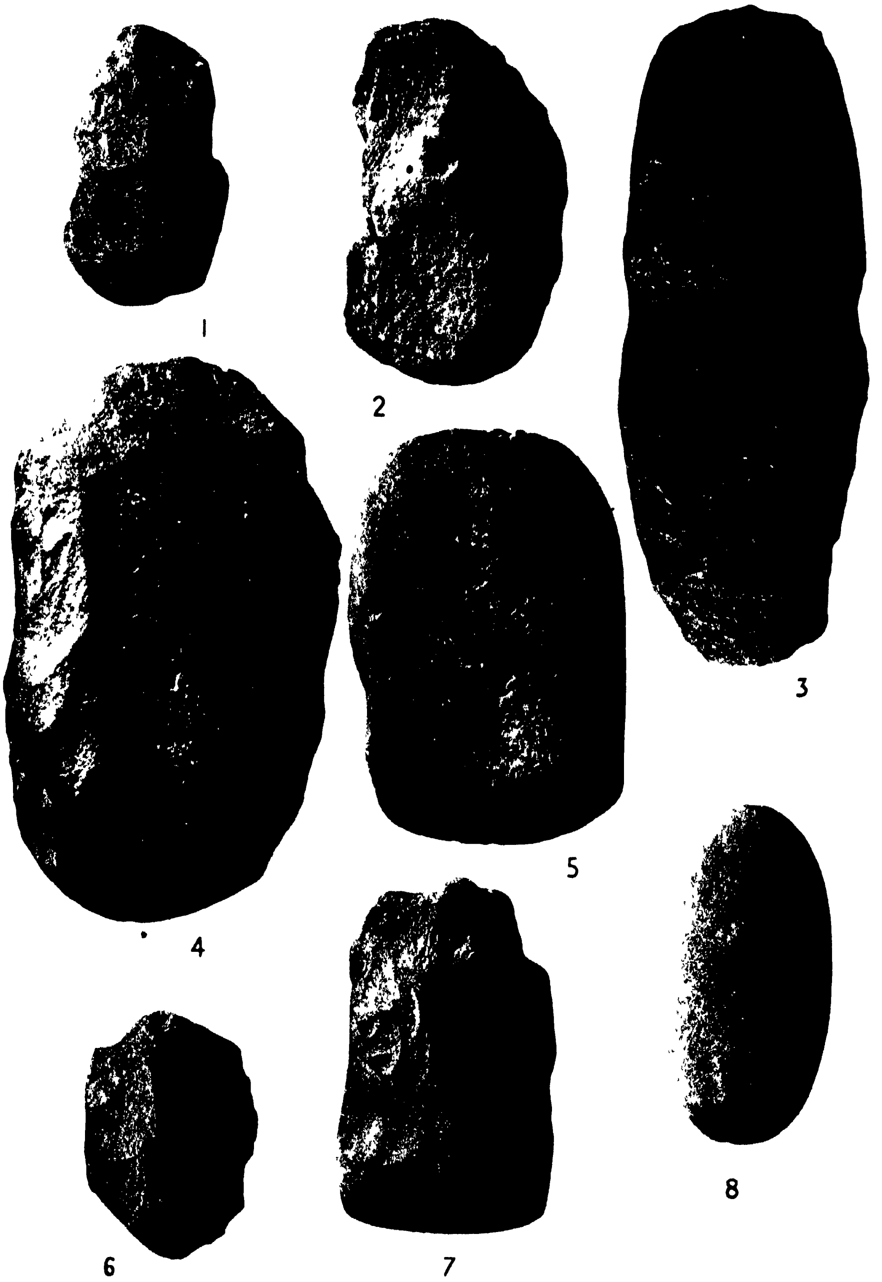

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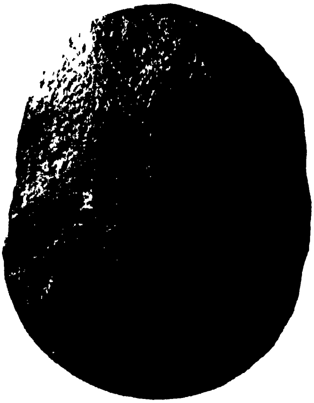

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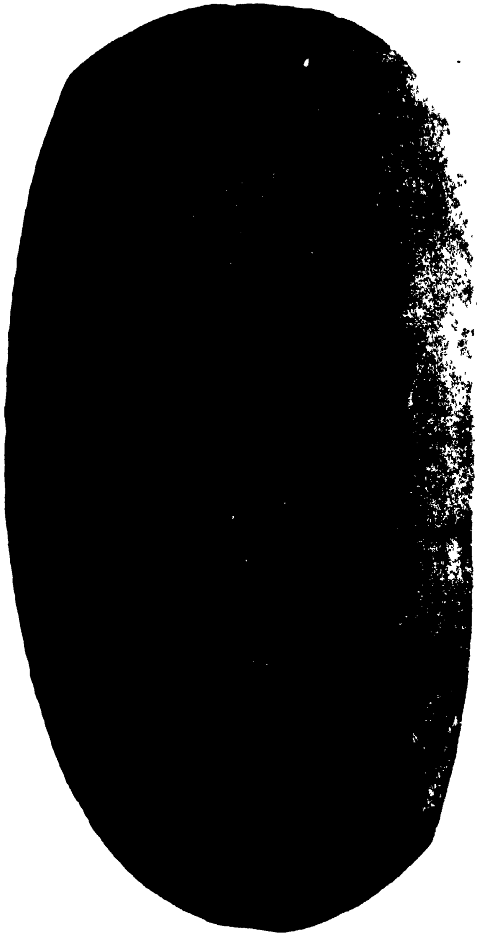

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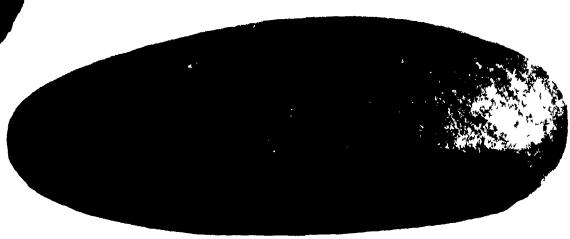

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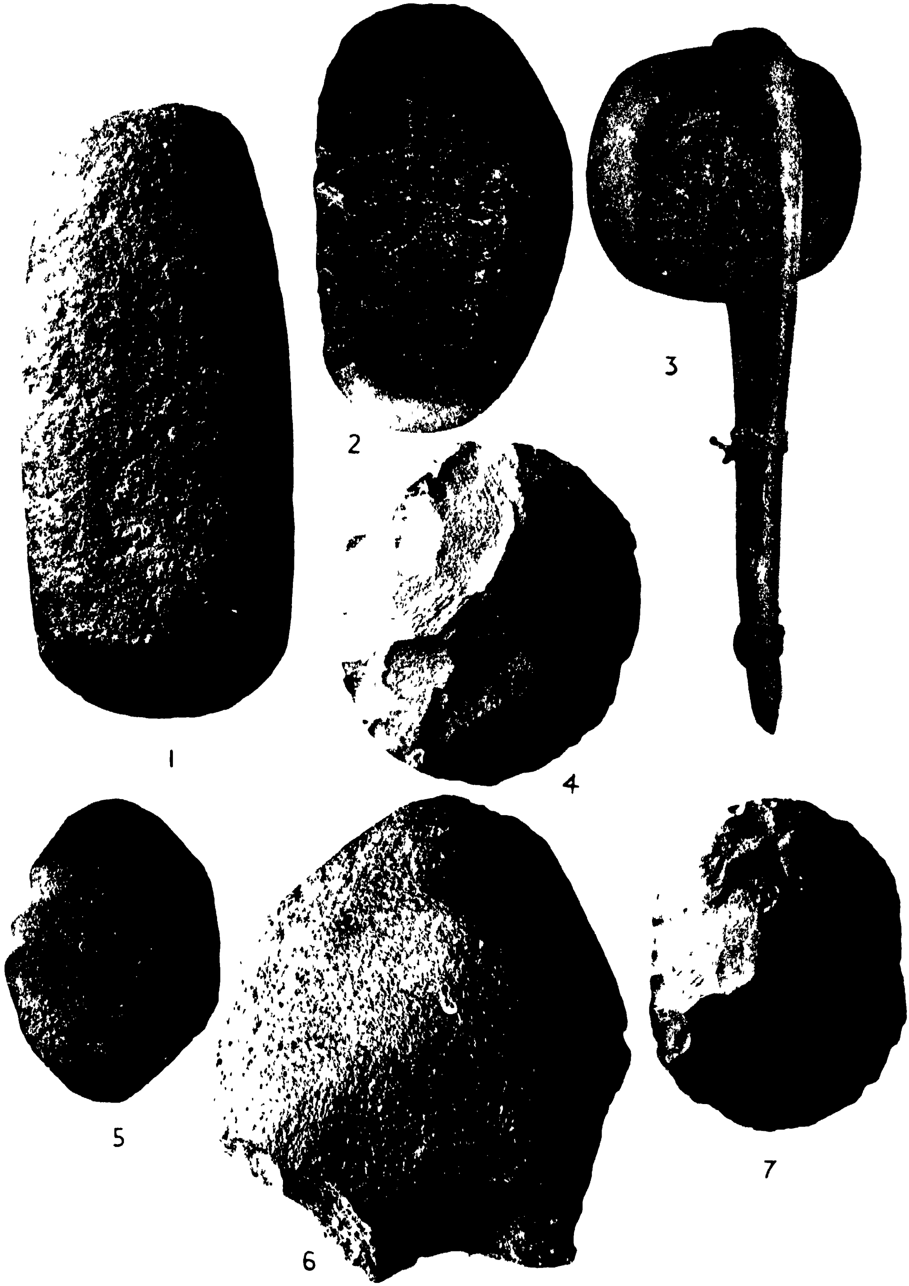

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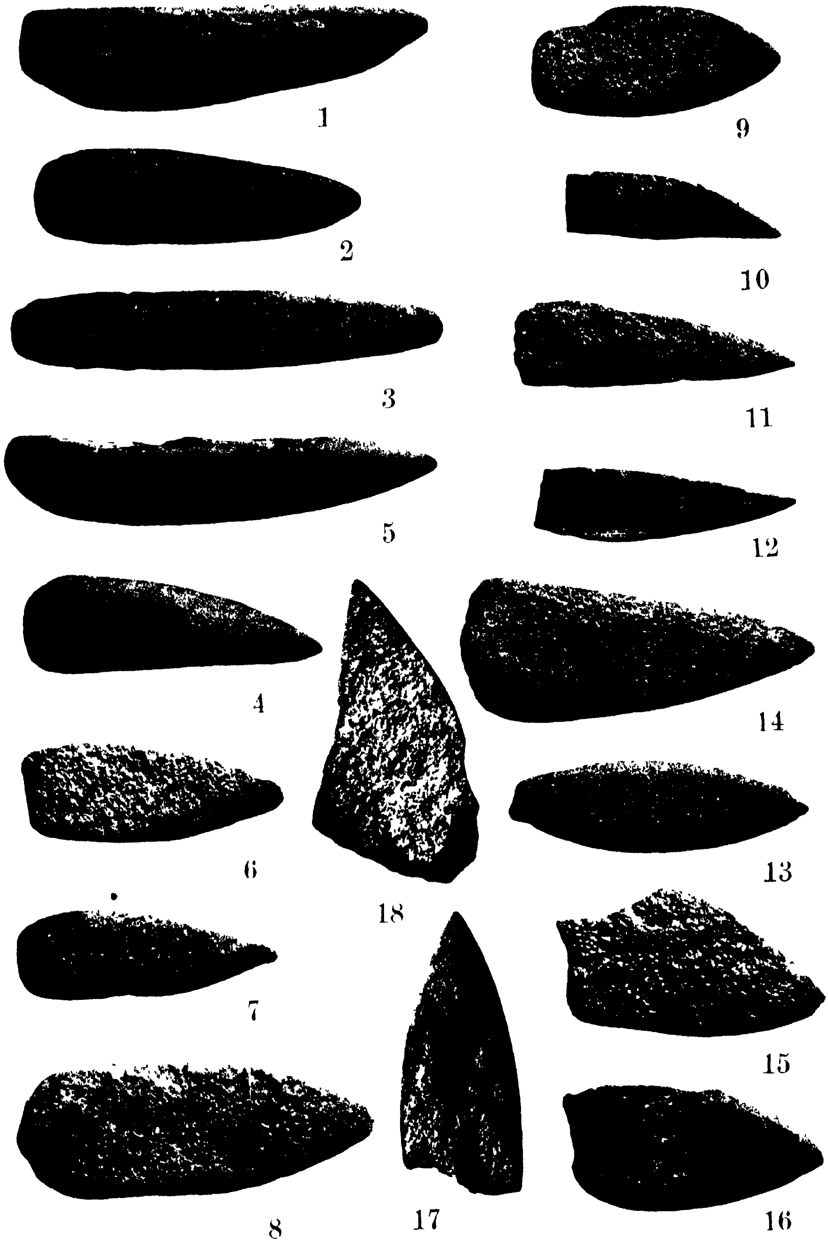

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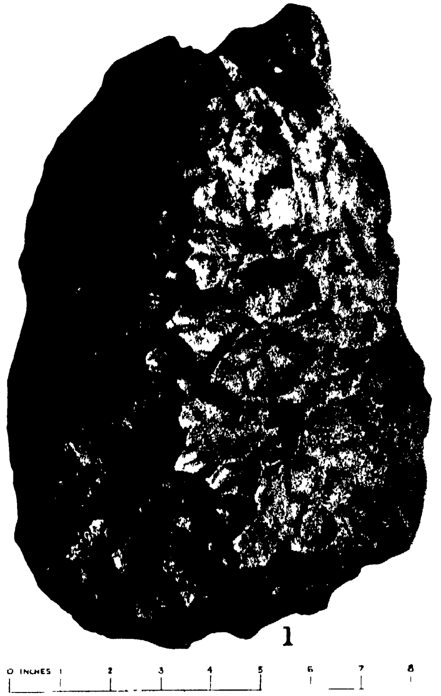

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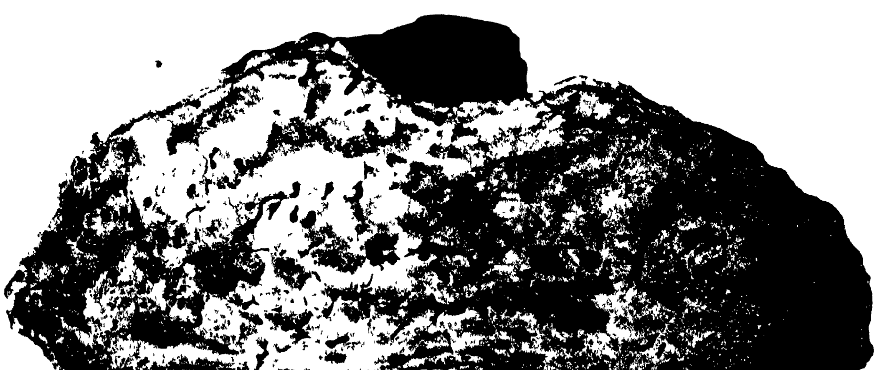

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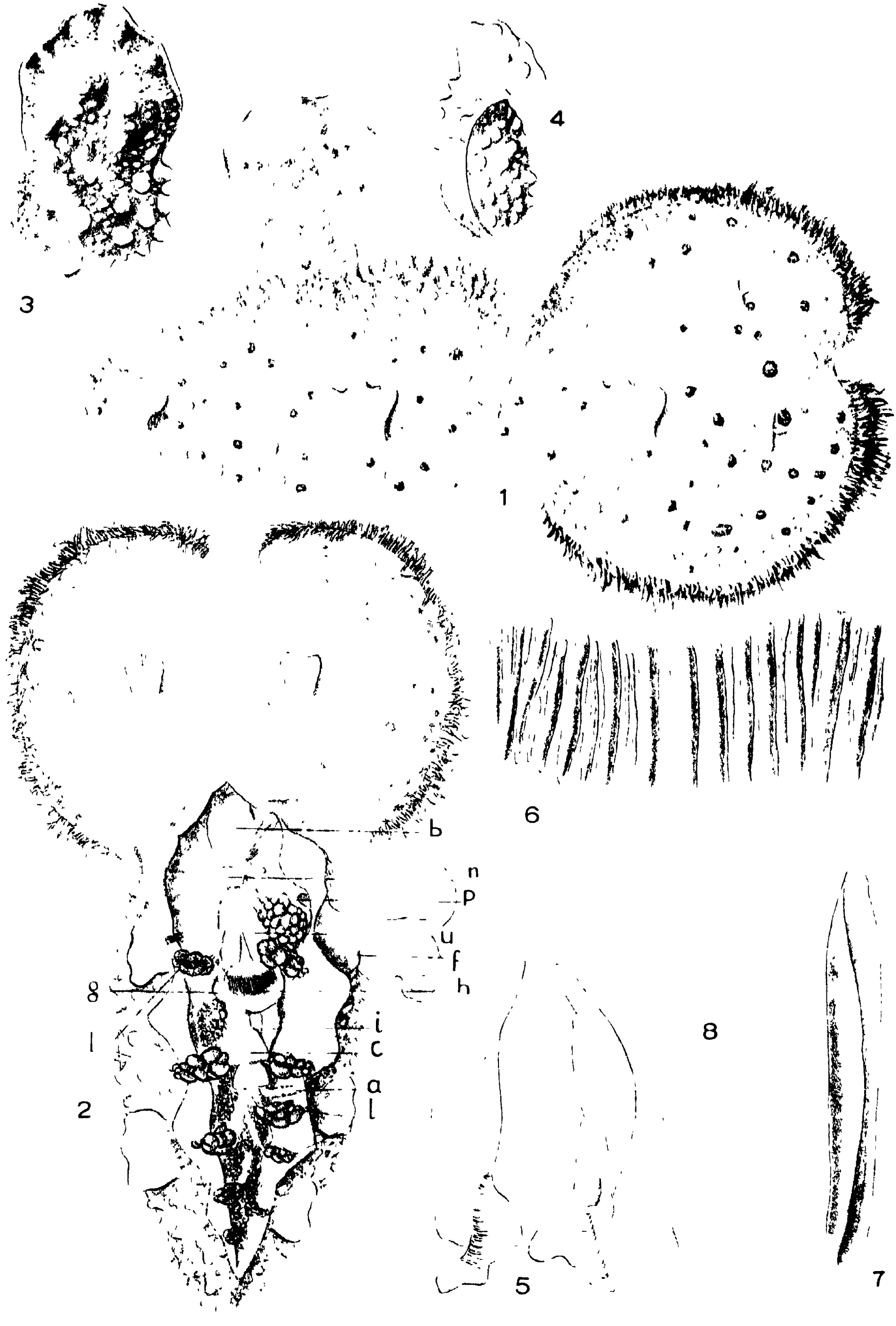
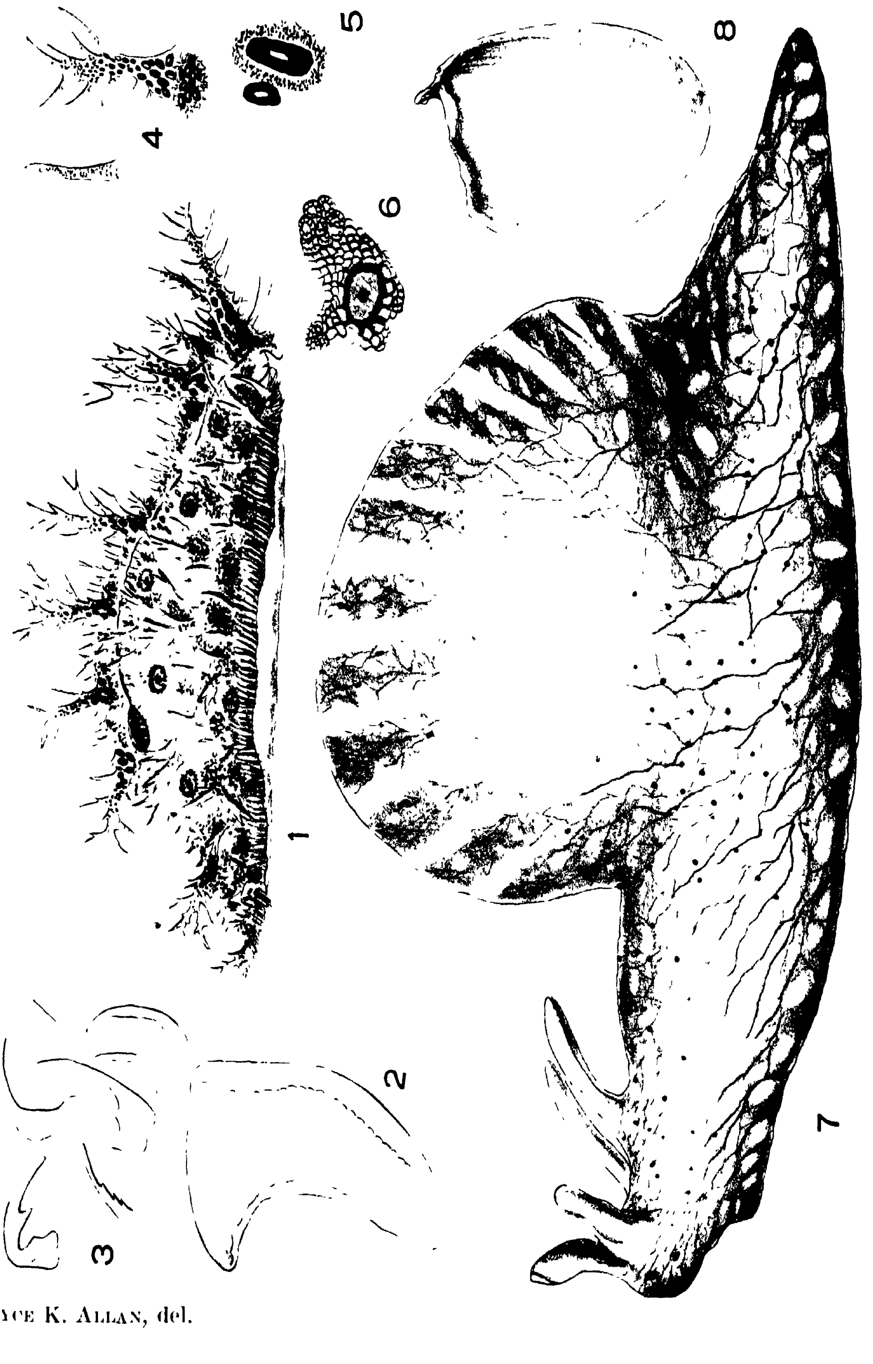
G. C. Clutton, photo.



JOYCE K. ALLAN, del.



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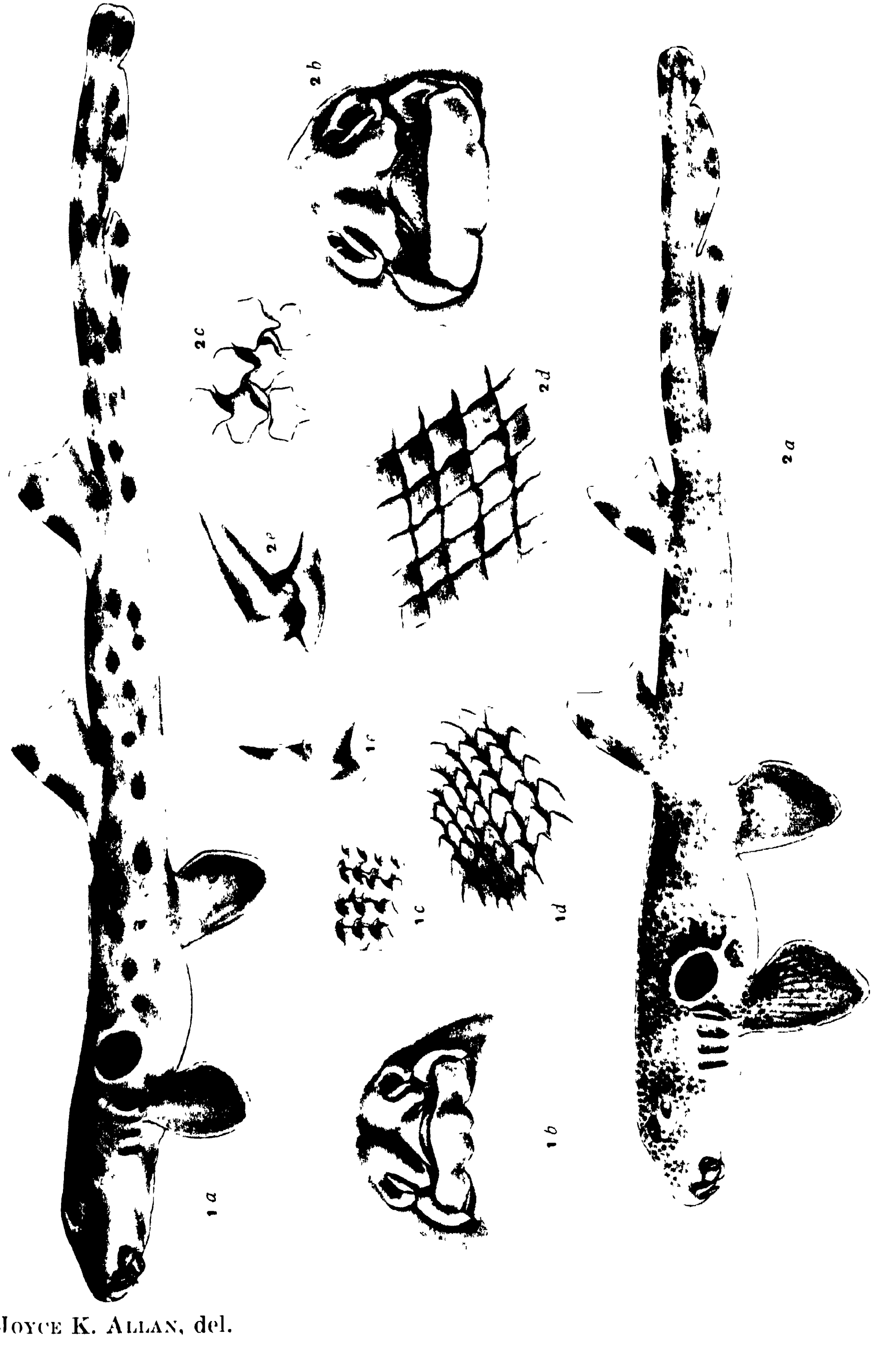

JOYCE K. ALLAN, del.

G. E. TANNER (1-3) and H. BARNES (4), photo.

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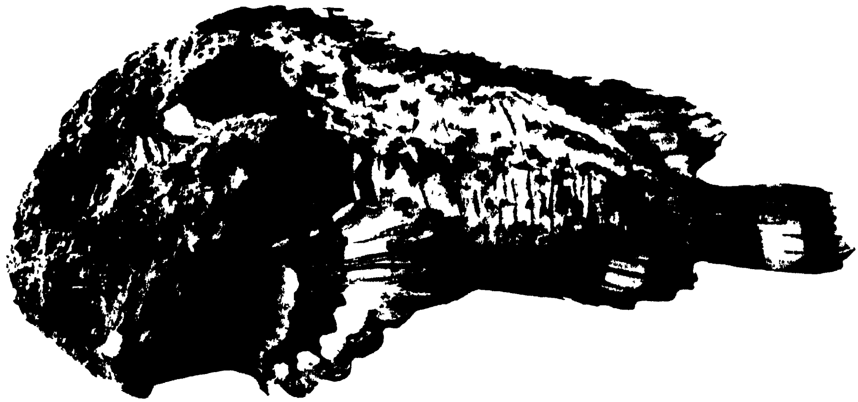

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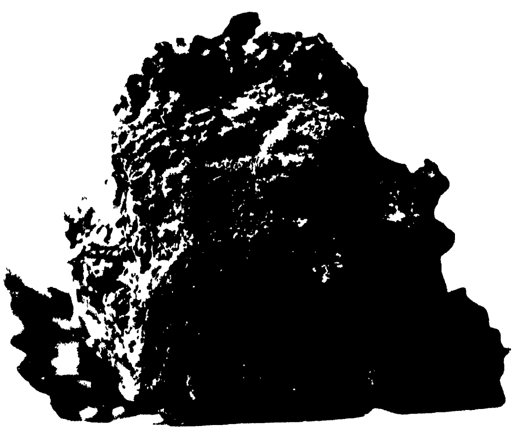

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JOYCE K. ALLAN (1), del.; G. C. CLUTTON (2 and 3) and DR. W. MACGILLIVRAY (4), photo.

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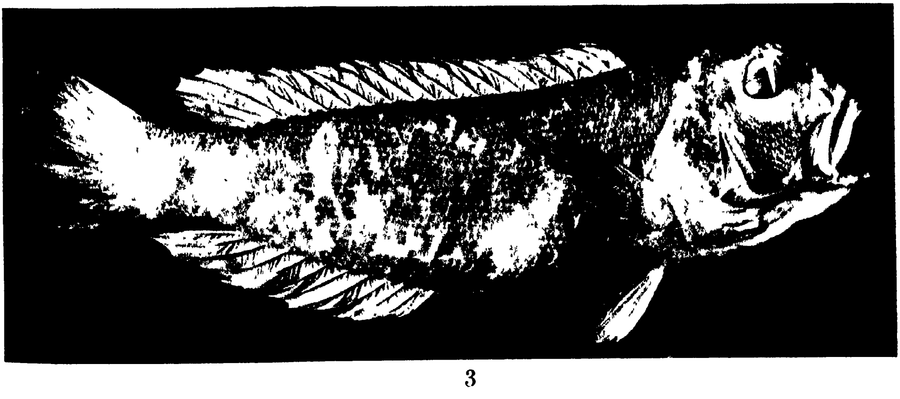

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G. C. CLUTTON, photo.

HERPETOLOGICAL NOTES.

No. 4.*

By

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Zoologist, The Australian Museum.

The following paper contains a note on the status of *Typhlops leonhardi*; descriptions of new subspecies of lizards belonging to the genus *Lygosoma*; and general notes relating to snakes, lizards, and frogs in the Australian Museum reference collection.

OHPHIDIA.

Typhlops leonhardi Sternfeld.

Typhlops endoterus Waite, Rec. South Austr. Mus., i, 1, 1918, p. 32, fig. 24.

Typhlops leonhardi Sternfeld, Abhandl. Senck. Naturf. Ges., i, 3, 1919, p. 77.

Though I have not examined the types of either of the above blind snakes, Sternfeld's description of *T. leonhardi* agrees so perfectly with Waite's description and figure of *T. endoterus* that I am forced to regard them as synonymous. Waite had three specimens and Sternfeld five, all of which were collected in the Hermannsburg district, Finckh River, south of the MacDonnell Range, Central Australia.

Cerberus australis Gray.

An excellent example of this species, which is in a good state of preservation in the National Museum, Melbourne, was collected at Port Darwin, North Australia, on September 14, 1887. Though previously recorded from Port Essington and other parts of North Australia, this is the only specimen, to my knowledge, which is definitely from Part Darwin.

Stegonotus modestus Dumeril *et* Bibron.

A specimen bearing a label with the doubtful locality "Ripple Creek, Queensland ?" has been in the collection for a number of years, but, on account of the question mark, it could not be regarded as an Australian record.

This species was always regarded as being distributed throughout the Moluccas and Papuasia, the nearest locality to Australia being Murray Island, Torres Straits. Through the recent acquisition of two specimens collected at Rocky River, near Coen, Cape York, Queensland, it may now be regarded as an

* For No. 3 see RECORDS OF THE AUSTRALIAN MUSEUM, XVIII, No. 5, 1931, pp. 267-70.

addition to the Australian herpetological fauna. Some characteristics of the Rocky River specimens are as follows:

Specimen A.—Rostral from above equal to about one-third its distance from the frontal, the latter shield being as broad as long, the length equalling its distance from the posterior border of the rostral. There are eight upper labials on the right side of the mouth, and seven on the left, there being a small one between the fourth and fifth on the right side. There are two preoculars and one postocular. Temporals 1 + 2. Ventrals 215; subcaudals in 81 pairs; scales in 17 rows; anal single.

Specimen B.—Rostral from above equal to one-third its distance from the frontal, the latter shield a little longer than broad, nearly as long as its distance from the end of the snout. Nine upper labials. There are two preocular and two postocular shields. Temporals 2 + 2. Ventrals 213; subcaudals in 82 pairs; scales in 17 rows; anal single.

A specimen from Ripple Creek, near Cardwell, Queensland, collected by A. J. Boyd in March, 1897, has the following characteristics: Rostral from above equal to about one-quarter the length of its distance from the frontal, which is as broad as long, and shorter than its distance from the posterior angle of the rostral. Nine upper labials. There are two preocular and two postocular shields. Temporals 2 + 3, or sometimes 2 + 3 + 3. Ventrals 233; subcaudals in 94 pairs; scales in 17 rows; anal single.

Demansia torquata Gray.

Previously recorded only from the north-eastern parts of Queensland, more particularly the coastal areas, this snake may now be placed among the more widely distributed species. One specimen, measuring 690 mm., was collected at Nappapirri, Cooper's Creek, south-western Queensland, by Dr. W. D. K. MacGillivray. Others in the collection are from the following localities: Percy Island, one; Mt. Morgan, one; Hughenden, central Queensland, two. These specimens range in length from 370 to 510 mm.

Except in size, the south-western specimen does not differ from the typical form. In the Mount Morgan specimen the frontal shield is almost as wide as the supraoculars, but in the others the frontal is strikingly narrow and elongated.

Notechis scutatus Peters.

A female specimen, measuring 800 mm. (tail mostly missing), was killed in Centennial Park, Sydney, on January 26, 1932. The oviducts contained nineteen undeveloped eggs. The stomach contained three young rats, *Rattus* sp., and one frog, *Hyla aurea.*

The specimen is exceptionally dark brown above, with the cross bands only on the anterior half of the body. The under surface is bluish, mottled with a darker shade posteriorly.

The Cowangie Mystery Snake.

Demansia textilis (?).

In January, 1928, the Rev. Walter Walters interested himself in the above, publishing his remarks in several Victorian country newspapers. These include the "Sunraysia Daily", "Ouyen Mail", and "Mallee Harvester". It was stated that

a number of naturalists had a suspicion that in the Mallee country of north-west Victoria, a new species of venomous snake had been discovered, when an unusually marked specimen, measuring five feet six inches, was killed, but unfortunately burned, by Mr. Alec McIntosh, of Cowangie. Later the remains of this specimen were exhumed by the Rev. Walters, who, after an examination, made a sketch of the head shields, subcaudals, and the colour pattern of the dorsal surface.

His figures show a small extra shield, interposed between the prefrontals, a narrow frontal, and single subcaudals. The specimen was a creamy colour, crossed with broad dark bands, about seven scales wide, while between each band were two narrow ones, each one scale wide, all being fairly evenly spaced.

Early in January, 1928, the problem was submitted to me for an opinion, but until quite recently I was not able to find any snake that would approach in colour and scalation the original one from Cowangie. In the National Museum, Melbourne, there is a specimen (Regd. No. R.11847), collected by Mr. D. Stewart at Cowangie, Victoria, on February 24, 1928. The head is black above and below, and the body markings are identical with those figured by the Rev. Walters, while there are 209 ventrals, 52 subcaudals, all divided, a divided anal, and scales in seventeen rows. This differs from the drawing made of the original specimen by having the subcaudals divided (a characteristic of the genus *Demansia*). If Rev. Walter's figure is correct, it would suggest that the snake belonged to the genus *Denisonia* or *Notechis*, but in the head shields and small scales it differs from both of these. I examined the specimen in the National Museum and found it to agree fairly well with *Demansia nuchalis*[1] in general characters, though in many ways it appeared intermediate between that and *D. textilis*.[2] The fact that the second Cowangie snake is identical in markings with the first, but has divided subcaudals instead of single ones, as figured by Rev. Walters, leads me to suspect that the exhumed specimen was so damaged that Walters may have been misled in regard to the subcaudals. The extra shield on the head is, of course, abnormal, such abnormal scales occurring only in an occasional individual.

A specimen received lately from Dr. W. D. K. MacGillivray, from Broken Hill, New South Wales, is apparently very closely related to the Cowangie snake. It has seventeen rows of scales, 207 ventrals, a divided anal, and 53 subcaudals. It will be noted that in this respect it is almost identical with Mr. Stewart's specimen. The markings differ only a little, the dark brown bands appear to be more widely spaced, and there are several one-scale-wide dark bands in the interspaces.

The head-shields of the Broken Hill specimen do not agree absolutely with the Cowangie specimen in the National Museum, nor do they quite agree with any other snake in the Australian Museum collection, but are much nearer *Demansia textilis*. This and several other intermediate specimens leads me to believe that some of the existing "species" of *Demansia* are merely subspecies, but it would be necessary to examine a large series to prove this. There are some characters which would indicate that the Broken Hill specimen is related to *D. guttata* Parker,[3] which also, in my opinion, is closely related to the Cowangie snake. Exactly to which species the latter belongs might remain a mystery for

[1] Boulenger.—Brit. Mus. Cat. Snakes, III, 1896, p. 326.
[2] Boulenger.—*Loc. cit.*, p. 325.
[3] Parker.—Ann. Mag. Nat. Hist., (9) XVII, 1926, p. 668.

some time, particularly because of the subcaudals being described (from a much deteriorated, exhumed specimen) as single. Possibly there are specimens in other Australian museums, and an examination of them by the authorities should do much to solve the problem. Owing to the great variability and very wide distribution of *D. textilis* and its varieties, I feel fairly confident that the "Cowangle Mystery Snake" is either a colour variety or a subspecies of *D. textilis*.

LACERTILIA.

Lygosoma (Hinulia) isolepis foresti, subsp. nov.

An examination reveals the following characters, which distinguish this from the typical *L. isolepis*.

The adpressed limbs fail to meet by a distance equal to the length of forearm. The distance between snout and forelimb is contained twice in the distance between forelimb and groin. Ear opening as large as eye opening. Seven upper labials, fifth below eye. Two pairs nuchals. Twenty-eight scales round the body. Twenty lamellæ under fourth toe, basal five divided. Preanals not greatly enlarged.

Colour.—Brownish above, two longitudinal broken lines formed by spots of irregular size, sides heavily spotted with brown, not nearly so dark as in *isolepis*. Scattered spots between shoulder and ear and on top of head. Under surfaces immaculate.

The total length of the specimen is 110 mm.

Locality.—Forest River, East Kimberley, Western Australia. Described from a single specimen collected in 1929 by L. Wood. Registered number, R.10001.

Lygosoma (Hinulia) tenuis intermedius, subsp. nov.

Although resembling *L. tenuis* closely, an examination of a splendid series of fourteen specimens revealed characters distinguishing it from the typical form.

The nuchals are more or less broken up; in some specimens the parietals are bordered by several large scales, with possibly one pair of nuchals behind them; one specimen has one distinct pair nuchals, others two or three pairs, three being the usual number. In several specimens the central row of scales (mid-dorsals) are distinctly broader than the others. In the whole series the laterals are distinctly the smallest.

Colour.—Pale brown above, more or less blotched with dark brown. Sides very dark brown, the majority of scales bearing one or more very small circular white dots. This lateral coloration extends from behind eye to base of tail, behind groin.

Holotype in Australian Museum. Reg. No. 6485.

Affinities.—This subspecies appears to be intermediate in characters and markings between *tamburinense* Lonnb. and And.,[4] *isolepis* Boul.,[5] and *tenue* Gray.[6] All the specimens differ from *isolepis* in not having divided lamellæ; from *tenue*

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[4] Lönnberg. and Anderson.—Handl. Kungl. Sven. Vet. Akad. Stock., LII, 7, 1915, p. 5.

[5] Boulenger.—Brit. Mus. Cat. Liz., III, 1887, p. 234, pl. xv, fig. 1.

[6] Boulenger.—*Loc. cit.*, p. 231.

in the presence and formation of nuchals, and from *tamburinense* in having 30 as against 32 rows of scales, and 17-20 lamellæ instead of 15. The colour of *tamburinense*, however, is evidently identical with that of some of my specimens. I have not had the opportunity of examining the types of any of these species, but suggest that *tamburinense* and *tenue* are eastern subspecies of *isolepis*.

Locality.—The specimens are all from the north coast of New South Wales. One from Richmond River, one from Ballina, Richmond, five from Clarence River, one from Dorrigo, one from East Dorrigo, and one locality unknown.

The specimens range in size from 110 to 204 mm.

Lygosoma (Hinulia) quoyi kosciuskoi, subsp. nov.

A very interesting series of four specimens, including both young and adult, from Mount Kosciusko, at altitudes varying from 3,000-7,000 feet. While the scalation varies very little from the typical *L. quoyi*,[7] the colour markings are very distinct. In the young specimens the prefrontals form a suture, but in one of the large specimens the point of contact can be seen only under a lens.

Interparietal slightly longer than fronto-parietal. Parietal does not form a suture behind interparietal (possibly abnormal). Fifth upper labial largest and below the eye. There are two pairs of nuchals present in the adult, behind large shields joining the parietal; nuchals absent in young. Ear opening not nearly as large as eye opening. There are from 36-38 scales round body, the ventrals being the largest. Adpressed limbs only just meet. Subdigital lamellæ divided, only 21 as against 27-32 in *quoyi*. Tail stout, not as long as head and body.

Colour.—Pale brown above, with three distinct longitudinal lines, the central one extending to base of tail. Lateral region heavily spotted and blotched with dark brown. A few scattered spots on head and ventral surfaces.

Holotype, regd. no., R.4654, in the Australian Museum. Total length, 150 mm., head 17 mm., body 78 mm., tail 72 mm., hind limb 25 mm., forelimb 18 mm.

The series ranges from 80-150 mm. in length.

In specimen no. R.4832, which is without locality, the head shields are abnormal: frontonasals semi-divided; internasals separated by a suture wider than that between rostral and frontonasal. Parietals are in contact behind interparietals. No nuchals. Eight large shields joining parietals. Twenty-two subdigital lamellæ. The other characters are normal. Length without tail, 75 mm.

Egernia luctuosa Peters.

An examination of three specimens shows them to differ slightly from the typical form in having the frontal as long as the interparietals and parietals combined. The colour markings also are very interesting. Dark blotches form somewhat regular longitudinal lines on the dorsal surface, the central one being broad though discontinuous anteriorly. In the light area bordering this line there is an indication of a narrow one on each side. Dark lines are more noticeable on the tail. The sides of the body are heavily blotched with dark markings intermixed with yellowish ones. A thick dark line extends from below the eye to the ear, below which is a yellow one, and another dark one from

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[7] Boulenger.—*Loc. cit.*, p. 230.

the gape to the ear. There are a few dark blotches on the head. Under surface immaculate.

All three specimens measure 240 mm. in length.

Locality.—One of the specimens is from King George's Sound, which is the type locality. The other two are from Western Australia, but from which part it is not known.

Tympanocryptis lineata cephalus Günther.

Since F. R. Zietz[8] placed the above in the synonymy of *T. lineata* Peters,[9] authors have been inclined to accept his decision. I have just examined three specimens which could be identified as *T. cephalus*[10] and, while I agree with Zietz that the differences are hardly specific, I consider them important enough to justify retention of *cephalus* as a subspecies of *T. lineata.*

The head scales of *T. lineata* from the parietal region forward are undoubtedly, and without much variation, strongly keeled, some bearing spines, while those of *T. lineata cephalus* are flatter and rugose. One striking difference, which evidently has escaped the observation of previous workers, is the horizontal position of the nostril. While the original description defines the nostril in *cephalus* as being much nearer the eye than the snout, no measurements are given, and the matter becomes one of comparison and liable to variation, therefore the value of such a character may be more apparent than real.

In *cephalus* the nostril is situated on the actual ridge of a very broadly rounded and ill-defined canthus rostralis, whereas in *lineata* the canthus is sharply defined, with the nostril situated below the ridge. The cause of the broad and flat canthus in *cephalus* lies in the large rugose head shields, of which there are from six to seven rows across the snout between the nostrils. Contrary to this, in *lineata* the shields on the canthus are narrow, elongated, and keeled, thus forming a sharp ridge, while across the snout, between the nostrils, there might be eleven or twelve rows of scales, all of which are distinctly keeled. The dorsal and ventral scales are less strongly keeled in *cephalus* than in *lineata*, as has already been observed, but the character is liable to a little variation and had best be discounted at present, though, of course, in the two extremes it is very obvious.

Of the three specimens before me as I write, one is from Laverton, Western Australia, one from Western Australia (no definite locality), and one from Ardmore, north-western Queensland, collected by T. Hodge-Smith, December, 1930. It was during the examination of the latter that I became aware of the mistake that had been made in placing *cephalus* in the synonymy of *lineata.*

Though Ardmore, Queensland, is a considerable distance from the type and other localities in Western Australia, the country between is dry and very much of a sameness throughout, so possibly *cephalus* might be scattered over the whole of these central parts of the continent.

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[8] Zietz.—Rec. S. Austr. Mus., I, 3, 1920, p. 198.
[9] Boulenger.—Brit. Mus. Cat. Liz., I, 1885, p. 392.
[10] Boulenger.—*Loc. cit.*, p. 393, pl. xxxi, fig. 1.

Moloch horridus Gray.

The youngest and smallest specimen I have ever seen of this species, measuring only 50 mm., was recently presented to this Museum by Mr. H. Harris, who collected it at Southern Cross, Western Australia. Except in size it does not differ from the adult. An adult grows to about 212 mm., the biggest in our collection being 180 mm.

Habits.—The late Edgar R. Waite recorded that the Moloch inhabited the sandy regions of the interior of South and Western Australia, and that it was known to feed on small, strongly smelling, black ants, licking them up from their run-ways. The late W. Saville Kent estimated that between one and five thousand of these ants are consumed at a single meal.

It appears, from the observations of naturalists and others, that the Moloch will not eat anything except ants, and, as it is very partial to the small black one of the region it inhabits, it is very difficult to keep in captivity for any length of time.

Quite lately I learned from an observer that, though the tracks of Moloch were often to be seen in the sand, the lizards could not be found by him, nevertheless the aborigines could find them within a very short time. My informer told me that he tried to keep the Moloch in captivity but found that they would not eat anything, even ants, that were introduced to the compound. He then built an enclosure through which the special black ants swarmed along their runway, but the Moloch took up its stand where the ants entered the enclosure, and in eating a number of the leaders, broke the line, and the ants soon found a way round, thus avoiding the lizard.

BATRACHIA.

Limnodynastes tasmaniensis Günther.

This burrowing frog has been dug up from sandy or clay soil on many occasions, but never from any great depth. The following note which is attached to a specimen in the National Museum, Melbourne, and which was written by Mr. E. B. Heyne, of Richmond, to the late Prof. McCoy, on the 10th November, 1868, is of particular interest.

"A few days ago I learnt that whilst excavating a cellar in my immediate neighbourhood the labourers had dug out of the ground from a depth of from six to eight feet of soil, damp clayish, several frogs. I asked to be supplied with one to be submitted to you and received on Saturday the specimen which I have now the honour to present for your inspection. Though probably not new to you it may nevertheless be of interest as I can vouch for its having been found embedded in clay without any crevices, through which it might have entered, being perceptible in the soil."

Myobatrachus gouldii Gray.

Two very large specimens of this interesting burrowing toad were recently added to the collection, having been secured at Tambellup, south-western Australia, by Mr. F. R. Bradshaw in September, 1930. The locality is about 140 miles inland from Albany in the south, and 200 miles from the western coast. This is the farthest inland that the species has ever been taken. The collector stated that he had handled between fifteen and twenty specimens at different times ranging

in size from about 25 mm. to 50 mm., and all were obtained in sandy country. Only two specimens previously were in the Museum collection, and both were males measuring: length, 26 and 33 mm.; breadth, 20 and 25 mm.; head, 7 and 9 mm. Mr. Bradshaw's specimens measure: male, length, 44 mm., breadth, 31 mm., head, 11 mm.; female, length, 57 mm., breadth, 48 mm., head, 12 mm.

Hyla citropus Günther.

Two specimens, male and female, of this small tree frog were brought to me in a bag by Mr. W. E. Schevill, Museum of Comparative Zoology, Harvard, collected by him a few hours earlier in the day at Stanwell Park Creek on the south coast of New South Wales. He informed me that the male was quite brown, while the female was deep green. On opening the bag the female was found as described, but the male had changed from brown to a light pale foliage green, the following being the colour of the moment: eye golden, flecked with brown; dorsal surface light foliage green becoming paler on the sides. From the nostril along the canthus rostralis was a thin golden line, terminating on the anterior part of the upper eyelid. From the posterior to the eyelid the golden line was thicker and bordered with brown, extending over the shoulder to the side where it broke up into fine golden flecks, giving the appearance of having been splashed with gold paint. These flecks extended to the groin, a few being on the thigh, but they gradually ceased to exist as the ventral surface was reached. The under sides of the lower jaw were pale green, merging into greenish white on the throat. The belly was pale salmon and the anal area a rich brown. The groin and hinder sides of the thigh were rich reddish tan, bordered above by maroon. The armpits were yellowish tan bordered above by a darker shade. The female was coloured the same, but the green was a much darker shade, without any trace of olive or brown.

The male was gradually changing the colour of its back while I wrote, and when I had completed the description had turned olive brown, all within five minutes of being taken from the bag. At the time of collecting, January 27, 1932, the species was mating, which season appears to be the usual one, for in February, 1930, in company with Mr. Joseph Slevin of the California Academy of Sciences, and Mr. Melbourne Ward, I found the same species mating in a pond fed by a permanent spring at Hampton, near Jenolan Caves, N. S. Wales.

Hyla citropus[11] is somewhat closely related to *rubella*[12] and *dentata*,[13] but is not so widely distributed as either of these, and is without doubt the rarest of the three. Its distribution is usually cited as eastern Australia, but that term is far too sweeping. In the Museum collection are specimens from several localities within forty miles of Sydney, while J. J. Fletcher records it from the Blue Mountains between Springwood and Mount Wilson. I have found it at Hampton (4,000 feet), midway between Mount Victoria and Jenolan Caves. At Hampton many of the males were brownish and the females green, as previously described. Fletcher had in his collection three specimens from Aberfeldy, Victoria, a town in the coastal area, some 122 miles east of Melbourne. This is a long way out of the zone regarded as the habitat of *citropus* and I would suggest that the

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[11] Boulenger.—Brit. Mus. Cat. Batrachia, III, 1882, p. 408.
[12] Boulenger.—*Loc. cit.*, p. 405.
[13] Boulenger.—*Loc. cit.*, p. 406.

specimens referred to belong to *H. dentata*. I think that the range of *H. citropus* extends from the county of Cumberland westward to the Blue Mountains, reaching the various localities from which they have been recorded *viâ* the Nepean and Grose River Gorge, and feeders to Mount Wilson on the northern side of the Great Western Railway, and *viâ* the Nepean and Warragamba Rivers, and through the Cox River to the Jamieson and Kanimbla Valleys on the southern side of the railway. By any of these, *H. citropus* could easily reach the central tablelands, and from there migrate along the streams of the western watershed, but it is not known just how far west they extend, probably not beyond the central tablelands.

Acknowledgments.—I wish to offer my sincere thanks to Mr. F. D. McCarthy for observations which assisted me greatly in the compilation of these notes; to Mr. W. Meliska, who kindly translated for me the whole of Dr. Sternfeld's paper on "Reptiles from Central Australia";[14] and to Mr. J. A. Kershaw, late director of the National Museum, Melbourne, who allowed me to examine many specimens in the herpetological collection of that institution.

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[14] Sternfeld.—Abhandl. Senck. Naturf. Ges., I, 3, 1919, pp. 76-83.

OUR PRESENT KNOWLEDGE OF AUSTRALIAN WATER-MITES (*HYDRACHNELLÆ* ET *HALACARIDÆ*).

By

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Bremen, Germany.

We know but very little till now about water-mites from Australia. The recently published description of a new genus and species of *Halacaridæ* and the redescription of a species of *Hydrachnellæ* gave a chance to compile what is known to-day about these animals.

I. HYDRACHNELLÆ.

1. FROM THE CONTINENT.

The first freshwater-mite known from the Australian Continent seems to be (1)* *Hydrachna odonthognatha* Canestrini,[1] collected from a water-beetle from Queensland.

About twenty years later W. J. Rainbow, in his "Synopsis of Australian Acarina",[2] added two more species: (2) *Eylais maccullochi* Rainb. and (3) *Unionocola cumberlandensis* (Rainb.) from ponds at Parramatta. Both species belong to the genus in which the author has placed them, but it seems impossible now to recognize the species and to compare them with others of the two genera.

In 1914 F. Koenike[3] described (4) *Unionicola cirrosa* Koen. from the gills of *Unio nepeanensis* Less. We do not know the habitat of this mite.

W. A. Haswell in 1922 published a study[4] on (5) *Astacocroton molle* Hasw. living in the gill-cavity of the common spiny crayfish (*Astacopsis serratus*). Haswell's paper is principally devoted to the internal anatomy of this interesting mite. It will be necessary to breed the larvæ of *Astacocroton* in order to understand its real relations and to fix its systematic position (*cf.* Viets, Zool. Anz., Bd. xcvii, 1931, p. 85).

Only these four species of *Hydrachnellæ* have been recorded from the continent till now, a very meagre result relative to this widely distributed group of Acari.

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* Running numbers.

[1] G. Canestrini.—Acari dell' Austria (Atti R. Instituto veneto sci., lett., arti. Venezia, (6), II, 1884 [separ. p. 27]).

[2] W. J. Rainbow.—Rec. Austral. Mus., VI, 3, 1906, p. 159.

[3] F. Koenike.—Abhandl. Nat. Ver. Bremen, XXII, 1914, p. 397.

[4] W. A. Haswell.—Proc. Linn. Soc. N.S.W., XLVII, 3, 1922, p. 329.

2. MARINE HYDRACHNELLÆ AND FAUNA OF THE ISLANDS.

The only known marine species of *Hydrachnellæ* is (6) *Litarachna denhami* (Lohm.)[5] from Shark's Bay, near Denham.

Some more work has been done in water-mites in the faunæ of the adjacent Australian islands. The following authors and mites may be cited:

F. Koenike,[6] 1900:

(7) *Eylais schauinslandi* Koen., from New Zealand, d'Urville, Cook Strait.

E. v. Daday,[7] 1901:

(8) *Lemienia multipora* (Dad.)
(9) *Piona piersigi* (Dad.)
(10) *Arrenurus koenikei* (Dad.)
} from New Guinea.

R. Piersig,[8] 1898 and 1904:

(11) *Arrenurus dahli* Piers.
(12) „ *laticodulus* Piers.
(13) „ *latipetiolatus* Piers.
(14) „ *altipetiolatus* Piers.
(15) „ *bicornutus* Piers.
(16) „ *lohmanni* Piers.
(17) „ *quadricaudatus* Piers.
(18) „ *matupitensis* Piers.
(19) „ *quadricornutus* Piers.
(20) *Oxus dahli* Piers.
} from Bismarck Archipelago.

A. C. Oudemans,[9] 1905 and 1906:

(21) *Limnesia jamurensis* Oudms. This is the immature stage (*Nymphophan*-stage) of a freshwater-mite, but it does not belong to the genus *Limnesia*.

Ch. Walter,[10] 1911:

(22) *Hydrachna mertoni* Walt.
(23) *Mamersa rouxi* Walt.
Arrenurus dahli Piers.
„ *quadricornutus* Piers.
(24) *Arrenurus pulcher* Walt.
(25) „ *alatus* Walt.
(26) „ *angustiscutatus* Walt.
(27) *Encentridophorus chelatus* Walt.
(28) *Piona bipunctata* Piers.
} From Terangan, Aru Islands.

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[5] H. Lohmann.—Marine Hydrachnidæ und Halacaridæ (Die Fauna Südwest-Australiens, II, 2, 1909, p. 151).

[6] F. Koenike.—Zool. Jbch., Syst., XIII, 1900, p. 125.

[7] E. v. Daday.—Mikroskopische Süsswassertiere aus Deutsch-Neu-Guinea (Termeszetr. Füzetek, XXIV, 1901, p. 50).

[8] R. Piersig.—In-und ausländische Hydrachniden (Zool. Anz., Bd. XXI, 1898, p. 569). Beiträge zur Kenntnis der Hydrachniden-Fauna des Bismarck-Archipels (Arch. Naturgesch., 1904, Bd. I, 1, p. 1-34).

[9] A. C. Oudemans.—Acarol. Aanteeken, XVII (Entom. Ber., Deel I, 1905, p. 223). Acari (Nova Guinea. Résult. Expéd. Néerlandaise., V, Zool., 1906, p. 101).

[10] Ch. Walter.—Hydracarina der Aru-Inseln. (Abh. Senckenberg. Natf. Ges., Bd. XXXIV, 1911, p. 209).

Ch. Walter,[11] 1915:

(29) *Eylais incerta* Walt.
(30) *Oxus orientalis* Walt.
(31) *Unionicola longiseta* Walt.
(32) „ *crassipalpis* Walt.
(33) *Encentridophorus sarasani* Walt.
(34) *Neumania neo-caledonica* Walt.
(35) *Piona diversa* Walt.
(36) *Arrenurus depressus* Walt.
(37) „ *multicornutus* Walt.
(38) „ *rouxi* Walt.
„ *dahli* Piers.

} From New Caledonia.

Ch. Walter,[12] 1929:

(39) *Piona pseudouncata* Piers. from Christchurch, New Zealand.

II. Halacaridæ.

1. Freshwater Halacaridæ from the Continent.

Only one species of freshwater Halacaridæ is known from Australia: (1) *Astacopsiphagus parasiticus* Viets,[13] occurring in the branchial chambers of *Astacopsis serratus*. This mite is the only species of this group of Acari living as a true parasite. Till now the nymphæ of *Astacopsiphagus* only have been described.

2. Marine Halacaridæ.

Our knowledge of the marine mites living between the tide marks and in the deep sea, the Halacaridæ *s. str.*, we find partly compiled in Rainbow's paper (*l.c.*, p. 161). There are few records since then and some synonyms should be added here.

Earliest of all authors in the group but not cited in Rainbow's synopsis we found Chas. Chilton,[14] who gave the description of *Halacarus parvus* Chilt. and *Halacarus truncipes* Chilt., taken between high and low water marks at Lyttelton Harbour, New Zealand. As pointed out in undertaking the re-description of Chilton's type-slides, the two species now should be named (2) *Agaue parva* (Chilt.) and (3) *Halixodes truncipes* (Chilt.).[15]

H. Lohmann[16] described several species from Sydney:

(4) *Agaue hispida* (Lohm.).
(5) „ *panopæ* (Lohm.).
„ „ forma *squamifera* (Lohm.).
„ „ forma *setifera* (Lohm.).

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[11] Ch. Walter.—Les Hydracariens de la Nouvelle-Calédonie (Sarasin and Roux, Nova Caledonia, Zool., II, ii, 7, 1915, p. 97).

[12] Ch. Walter.—Hydracarinen aus Java (Treubia, XI, 2, 1922, p. 221).

[13] K. Viets.—Über eine an Krebskiemen parasitierende Halacaride aus Australien. (Zool. Anz., XCVI, 1931, p. 115).

[14] Chas. Chilton.—On two marine mites (Trans. New Zealand Institute, XV, 1883, p. 190).

[15] K. Viets.—Die Halacaridae der Nordsee. (Z. wiss. Zool., CXXX, 1927, p. 89, 91).

[16] H. Lohmann.—Ergebnisse d. Plankton-Exped., Bd. II, G, a, b, 1893.

(6) *Agaue chevreuxi* (Trt.).
(7) *Copidognathus pulcher* (Lohm.).
(8) „ *lamellosus* (Lohm.).
(9) *Halacarus oblongus* (Lohm.).

Later on[17] H. Lohmann added to these mites:

(10) *Copidognathus australiensis* (Lohm.).
(11) *Agauopsis hirsuta* (Trt.) and *Agaue panopæ* (Lohm.) from Western Australia (Shark's and Champion Bay).

The number of 39 known species of Hydrachnellæ and 11 of Halacaridæ is small considering the large dimensions of continental and oceanic Australia, the great number of species known from other parts of the world, and the number of water mites in particular, or the Acari in general. Further investigations, especially in running waters as creeks, streams, and springs, surely will bring valuable results for zoogeography. For determination water-mites should be preserved in a solution of 3 vols. water + 2 acetic acid + 5 glycerine, not alcohol or formaline.

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[17] H. Lohmann.—Fauna Südwest-Australiens, *l.c.*, 1909, p. 153.

SOME FURTHER NOTES ON SPECIES OF *TAMARIA* (ASTEROIDEA).

By

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(Plates xl-xlii and Figures 1-2.)

A further study of the complex species of the genus *Tamaria* Gray has resulted in the discovery of two species believed to be undescribed and a new and surprising record for *T. megaloplax* (Bell). I am indebted to Mr. C. C. A. Monro, of the British Museum (Natural History), for the interest he has taken on my behalf and for the preparation of photographs of the specimens referred to in this contribution. As the rules of the British Museum prevent the loan of specimens for examination, I am not able to study the actual material, yet, in view of the fact that the photographs before me show all that is necessary, I am of the opinion that the action taken herein to describe the specimens is fully justified. As a measure of precaution, however, I sent the manuscript to the British Museum in order to have the descriptions compared with the actual specimens and the various points verified.

The three specimens referred to in this paper were examined by Bell and labelled "*Linckia megaloplax*". The two described as new are the specimens upon which Bell[1] founded the records of *megaloplax* from Dammer Island, Banda Sea, and Parry Shoal, off Cape Van Dieman, Melville Island, North Australia. These two records have accordingly been sunk as synonyms under the new species. As to the Holothuria Bank record we know that some of Bell's material from that locality, labelled *L. megaloplax* by Bell himself, was referred to by Clark (1921) under the heading of *Tamaria fusca*, but I have pointed out elsewhere that the record applied neither to *megaloplax* nor *fusca* but to Koehler's two species *ornata* and *hirsuta*. With this present specimen, labelled by Bell himself, and coming from Holothuria Bank, it is clear that Bell had at least one of his many specimens from that locality correctly determined.

From available information one concludes that the genus *Tamaria* embraces a greater number of species within a small area than was hitherto thought probable. The merging of Koehler's two species *ornata* and *hirsuta* under *fusca* Gray has been pointed out in an earlier paper to be erroneous, so that within the area formed by Cape Jaubert, near Broome, in the west, Gladstone in the east, and Dammer, Aru and Kei Islands, Banda Sea in the north, we find the following species: *T. pusilla* (M. and Tr.), *T. fusca* Gray, *T. megaloplax* (Bell) =

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[1] Bell.—Proc. Zool. Soc., London, 1894, p. 395.

tuberifera (Sladen), *T. ornata* Koehler, *T. hirsuta* Koehler, *T. tumescens* Koehler, *T. propetumescens* sp. nov., *T. ajax* sp. nov., and a *Tamaria* sp. (as yet undetermined—see paper on British Great Barrier Reef Expedition (Asteroidea), 1932, p. 261).

Tamaria megaloplax (Bell).

(Pl. xl, figs. 1–4.)

Linckia megaloplax Bell., Zool. "Alert", 1884, p. 126 (Albany Island specimen).
Linckia megaloplax Bell, Proc. Zool. Soc. London, 1894, p. 394—in part.
Tamaria megaloplax Livingstone, British Museum (Nat. Hist.), Great Barrier Reef Exped., 1928-29; Sci. Reports, iv, No. 8, Asteroidea, 1932, p. 259, pl. ix, figs. 1-3, pl. xii, figs. 8, 12, 14 (and synonymy).

A specimen with R. = 58 mm., housed in the British Museum (Natural History), and bearing a locality label marked Holothuria Bank, agrees with the characters of *megaloplax* so well that I am confident it has no association with Bell's other specimens from Holothuria Bank referred to by Dr. H. L. Clark (1921).

This extension of the range of *megaloplax* is surprising; it was at first thought by me to be confined to east and north-eastern coasts of Australia, but now it is evident that *megaloplax* has a greater Australian range than was hitherto suspected. Bell's record (*loc. cit.*) included this specimen in a batch of wrongly identified material later referred to by Clark (1921) and shown by me in an earlier paper[2] to be referable to *ornata* and *hirsuta*. It is obviously the only specimen of *megaloplax* from Holothuria Bank handled by Bell.

Tamaria propetumescens sp. nov.

(Pl. xlii, figs. 1–5, and Figure 1.)

Linckia megaloplax Bell, Proc. Zool. Soc. London, 1894, p. 395—in part (*non* Bell, Zool. "Alert", 1884, p. 126, Albany Island specimen).

Description.—R. = 38·5 mm., r. = 6 mm., R. = 6·4 r. Rays five. The disc is elevated. The rays taper gradually and evenly to a round, blunt, and slightly upturned tip. The papular areas are arranged in six rows. The row bordering the median radial series of abactinal plates on either side merge at a point within the distal half of the ray. This character is clearly noticed in *tumescens* (Koehler). The papular areas are distinctly sunken. From four to eight pores occur to an area, the number decreasing with the tapering of the rays. The abactinal plates are uniformly tumid and are arranged in regular longitudinal series. They are covered with a distinct and dense granulation. The granules in the central areas are, for the most part, the largest to be found on the abactinal surface. The disc bears the largest plates, which are irregular in shape. The plates of the median radial series, with the exception of the primaries, are more or less similar in shape, being roundly rectangular. The plates of the adradial series are more or less squarish in outline. Only a single series of adradial plates is present. In every case this series of plates terminates at a point

[2] Livingstone.—Brit. Museum (Nat. Hist.), Gt. Barrier Reef Exped., 1928-29; Sci. Repts., iv, No. 8, 1932, p. 257.

within the distal half of the ray, thus bringing together near the tip of the ray the median radials and the superomarginals. The terminal plate is of moderate size and sparsely covered with granules. The madreporite is situated near the edge of the disc; it is slightly concave from top to base and measures 6 mm. across its widest part, *viz.*, from side to side.

Pedicellariæ of the type usually found in the genus occur on almost all the adradial plates. None occur on either the centro-dorsal plates or plates of the median radial series. They are two-jawed and spatulate, each jaw being slightly curved and denticulate (see Figure 1). Pedicellariæ occur only sparingly on the actinal surface.

Figure 1.
Tamaria propetumescens sp. nov.
Pedicellaria from holotype.
C. C. A. Monro, *del.*

The actinal surface is covered with densely packed granules, making the plate formation indistinguishable. No papulæ are to be found on the actinal surface. Many inferomarginal plates bear a stout, conspicuous, central conical tubercle similar to those seen in *T. megaloplax* (Bell). These tubercles are fairly numerous, particularly upon inferomarginals in the distal half of the ray. The spinelets of the furrow series can be distinctly seen, and are more or less alternately stout and thin. Only a single series of subambulacral spines is present. They are placed close together and run without much variation in position right down to the oral spines. The subambulacral spines are separated from those of the furrow series by a single though very definite row of small granules.

Colour.—In dry specimens the colour has disappeared (*fide* Mr. C. C. A. Monro).

Affinities.—There is no doubt about the close relationship the above species bears to *T. tumescens* (Koehler).[3] So far as the abactinal surface is concerned practically no differences can be readily detected, but the actinal surface of *propetumescens* is seen to be clearly different to that of *tumescens*. *T. propetumescens* can be separated from *tumescens* by the following characters. The superomarginals do not overlap the inferomarginals to form a definite channel between these two series of plates. The inferomarginals are not clearly defined by grooves as are seen in *tumescens*. Many inferomarginals are provided with stout conical tubercles which are entirely absent in *tumescens*. The subambulacral spines, although only in a single series, are more regularly arranged and run down closer to the mouth than is the case in *tumescens*. Moreover, the subambulacral spines are not placed immediately next to the furrow series but are separated from these latter by a definite row of small granules.

In *propetumescens* the number of papular pores to an area is considerably less.

[3] Koehler.—Abh. Senckenb. Naturf. Ges., xxxiii, 1910, p. 281, pl. xvi, figs. 3-4.

Locality.—Parry Shoal, 37 miles westward of Cape Van Dieman, Melville Island, North Australia.

Tamaria ajax sp. nov.
(Pl. xli, figs. 1–5, and Figure 2.)

Linckia megaloplax Bell, Proc. Zool. Soc. London, 1894, p. 395—in part (*non* Bell, Zool. "Alert", 1884, p. 126—Albany Island specimen).

Description.—R. = 41·5 mm., r. = 7 mm., R. = 5·9 r., br. (at base of ray) 7·5–8 mm. Disc moderate in size. Rays strong and robust, each gradually tapering to a rounded and upturned tip; the rays may be described as slender when compared with those of *T. triseriata* (Fisher). The terminal plate is of fair size, very conspicuous, and carries two or more tubercles. The rays are well arched and slightly flattened actinally. The interbrachial arcs are rather acute.

The plates of the abactinal surface are tumid or swollen. They are arranged in regular series, which are separated from one another by six channels containing the papular areas. The median radial series of plates are of uniform shape and grow gradually smaller in size as they approach the tip of the ray. The primary plate of each series, is, in the majority of cases, the largest plate on the abactinal surface. The primary plates and adjoining plates on the disc collectively, form a kind of polygonal crown. The plates on the disc, as well as those forming the median radial series, each bear central granules of large size. These granules are of considerable size on plates of the median radial plates in the distal half of ray. The superomarginals are provided with large central granules, which could be more aptly termed tubercles on account of their large size. The granulation of the abactinal surface is otherwise almost uniform. A single series of adradial plates occurs between the median radials and the superomarginals. These adradial plates are smaller than the median radials and in addition possess a more or less uniform type of granulation. The adradial series ends or fades out at a point about two-thirds the distance along the ray. From the point of disappearance onwards to the tip of the ray the median radial plates and the superomarginal plates are separated only by a single series of papular areas. Six rows or series of papular areas are present. The series bordering the adradial plates on either side merge at the point of disappearance of the adradial plates and continue onwards to the tip of the ray as a single series of papular areas. The number of pores to an area ranges from six to thirteen on the greater part of the ray, but near the tip only two or three are to be seen to an area. The disc bears papular areas containing pores ranging from six to ten in number. The anal aperture is a little removed from the centre of the disc and is surrounded by a large number of well-developed granules. The madreporite is roughly semicircular and measures 3 mm. across its widest part.

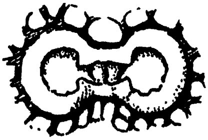

Figure 2.
Tamaria ajax sp. nov.
Pedicellaria from holotype.
C. C. A. Monro, *del.*

The granulation of the actinal surface is, on the whole, coarser than that of the abactinal surface. The inferomarginals in the distal half of the ray bear large central conical tubercles like those on the superomarginal series.

The furrow spinelets are flat and blade-like and are arranged in alternating large and small series. The tips are distinctly squarish and not rounded. A single series of subambulacral spines occurs. These spines are large and conspicuous and are directed outwards. The series is separated from the furrow spines by a single though clearly discernible series of granules.

Pedicellariæ occur sparsely and are to be found mostly on the abactinal surface. They are characteristic of the genus, two-jawed and spatulate. Only signs of denticulation are to be found (see Figure 2).

Affinities.—The nearest known relative of *ajax* is *T. triseriata* (Fisher).[4] Characters which render a separation easy are as follows.

The rays are more slender in *ajax*. The plates of the median radial series in *ajax* are more regular in size and possess central areas covered by large tubercle-like granules which do not occur in *triseriata*. The supero- and infero-marginal plates in *ajax* in the distal half of ray are provided with large, central, conical tubercles which are absent in *triseriata*. Only one series of subambulacral spines are present in *ajax*, whereas *triseriata* possesses two. No naturally naked plates occur on *ajax*. The average number of papular pores to an area in *ajax* is considerably in excess of that given for *triseriata*. The pedicellariæ in *ajax*, although two-jawed and spatulate, are neither curved nor narrow. In *ajax* the free extremity of each furrow spinelet is squarish and not "round tipped to truncate" as described for *triseriata*. Moreover, the furrow spinelets in *ajax* are not of equal size, particularly in the distal half of the ray.

Colour.—"Spirit specimen pale buff coloured; actinal surface mottled with brown" (*fide* Mr. C. C. A. Monro).

Locality.—Dammer Island, Banda Sea.

EXPLANATION TO PLATES.

PLATE XL.

Fig. 1.—*Tamaria megaloplax* (Bell). Actinal surface of Bell's Holothuria Bank specimen (slightly over natural size).

Fig. 2.—Portion of abactinal surface of ray of same specimen (× 4).

Fig. 3.—Portion of actinal surface of ray of same specimen (× 4).

Fig. 4.—Abactinal surface of same specimen (slightly over natural size).

PLATE XLI.

Fig. 1.—*Tamaria ajax* sp. nov. Actinal surface of holotype (slightly under × 2).

Fig. 2.—Proximal portion of abactinal surface of ray of same specimen (× 4).

Fig. 3.—Distal portion of abactinal surface of ray of same specimen (× 4).

Fig. 4.—Portion of actinal surface of ray of same specimen (× 4).

Fig. 5.—Abactinal surface of same specimen (slightly under × 2).

PLATE XLII.

Fig. 1.—*Tamaria propetumescens* sp. nov. Actinal surface of holotype (slightly under × 2).

Fig. 2.—Enlarged portion of abactinal surface of ray of same specimen showing pedicellariæ (× 4).

Figs. 3-4.—Enlarged portion of actinal surface of ray of same specimen (× 4)

Fig. 5.—Abactinal surface of same specimen.

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[4] Fisher.—Bull. U.S. Fish. Comm., xxiii, 1903 (1906), p. 1080, pl. xxx, fig. 3, pl. xxxi, figs. 7-7a.

THE AUSTRALIAN SPECIES OF *TOSIA* (ASTEROIDEA).

By

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(Plates xliii-xliv.)

The opinion held by Fisher (1911) that the Australian forms are best kept together in the genus *Tosia* and the American and European forms relegated to allied genera such as *Ceramaster* and *Plinthaster*, appears to be not only the most reasonable solution to the problem, but also the most natural course out of a maze of difficulties. The proposition, however, solves for the present only part of the task for the systematist and, indeed, must be regarded as only an initial step in the reorganization of sea-stars of the Australian seas. A problem yet to be faced is the relationship of *Tosia* with *Pentagonaster*, which is not yet clearly understood, but it is felt that, when the question is fully investigated by one with sufficient data, the merging of both genera will be the only alternative.

Just as intricate and detailed is the task of separating the species. It is the purpose of the present paper to attempt a reorganization of the Australian species so far as available material will allow; to give the results of a study of the relative values of specific characters and a statement of their uses and practical application. Moreover, it will be of great assistance to future workers to have the Australian species assembled under one heading and to have also a range of figures which will render the species more easily recognizable.

The species mentioned herein are as follows; the status of each species is included:

- *Tosia australis* Gray, genotype (valid).
- *T. aurata* Gray (valid).
- *T. astrologorum* (M. and Tr.) (a synonym of *T. australis*, or, at most, only a variety of that species).
- *T. tubercularis* Gray (valid).
- *T. grandis* Gray (? synonym of *T. aurata* Gray).
- *T. rubra* Gray (doubtful).
- *T. queenslandensis* Liv. (valid).
- *T. minima* (= *Pentagonaster minimus*) (Perrier) (in synonymy of *T. tubercularis* Gray).

THE GRANULATION OF THE ACTINAL SURFACE AS A SPECIFIC CHARACTER.

(Only species represented by series are discussed under this head.)

(*a*).—In *T. aurata* Gray.—In this species the actinal granulation is not governed by growth. Four specimens of almost equal size (three with R. = 36 mm. and one with R. = 33 mm.) show the character to vary to a marked degree. In

one extreme case the actinal granulation is complete, no bare plates being seen. In the other extreme case seventy-two actinal plates are bare. These plates occur near the edge of the body as well as near the centre. In smaller specimens (R. less than 33 mm.) the number of bare actinal plates are few (0–16). A variation is also noticeable in specimens exceeding R. = 36 mm. up to 69 mm. R. measurement.

Conclusion.—The degree of actinal granulation is useless as a specific character and so is the arrangement of bare actinal plates.

(*b*).—In *T. australis* Gray.—In ten specimens ranging from R. = 6 mm. to R. = 16 mm., the actinal granulation varies from a complete covering of every plate to a complete nakedness, excepting, of course, the usual row of granules at the periphery. In specimens over R. = 16 mm. up to R. = 33 mm., all plates are bare, excepting some at or near the margins, which are entirely covered, but the number of series of granules at the periphery of the plates varies from 1 to 3.

In the light of the above facts it is clear that the variation in the granulation of the actinal surface is not entirely due to growth.

Conclusion.—Like *aurata*, the actinal granulation cannot be relied upon as a specific character.

(*c*).—In *T. tubercularis* Gray.—All the specimens of a series of eight from one locality (Port Fairy, Victoria), with R. ranging from 11 mm. to 23·5 mm., show a very decided granulation on the actinal surface and in only one example are bare plates to be seen. In this specimen the bare plates number eighteen. A reversal of this finding is seen in Gray's earlier descriptions (1847 and 1866). Gray described his specimens as bare actinally, the plates having only a single series of granules at the periphery. However, the statement is qualified in the following words from Gray (1866): "Var. ? or young? The ossicula of the oral surface near the edges covered with granules." From the information available at present, it is clear that the actinal granulation of the species is not constant in either its presence or absence.

Conclusion.—It seems that, as in *australis* and *aurata*, the degree of granulation found on the actinal surface of the species must be discarded as a specific character, or must, at least, be used with caution.

The Value of Other Specific Characters.

The formula R. = K.r. should not be relied upon unless employed in cases where a clearly distinguishable range can be obtained, *e.g.*, between *australis* and *tubercularis*. In the case of these two species the formula is very useful, and, as the present range of specimens shows, reliable.

The number of superomarginals is a good and useful guide when the numbers are sufficiently at variance to justify the employment of the character, *e.g.*, in *australis* and *aurata*. On the other hand, it would be a useless character to employ in the separation of young specimens of *tubercularis* and *australis*.

The degree of convexity of abactinal and marginal plates, so far as can be ascertained, is a reliable specific character.

While the structure and size of the last superomarginal plate is useful it should be employed only in association with other characters. The size of the terminal plate, however, is a very good character; it at once distinguishes

T. queenslandensis from all other members of the genus and fortunately it appears to be constant.

The presence or absence of pedicellariæ is a reliable character.

Key to the Australian Species of *Tosia*.

(*T. grandis* and *T. rubra* have been omitted as they are only imperfectly known.)

a. Terminal plate small, inconspicuous.

b. Superomarginal plates 6 to 8 on each side.

c. Median radials and adjoining abactinal plates, as well as superomarginals, markedly convex. Pedicellariæ may occur.

d. Interbrachial arc comparatively acute (R. = 1·6 to 1·9 r.). Minute actinal pedicellariæ present .... *tubercularis*

dd. Interbrachial arc more obtuse (R. = 1·5 or less r). No actinal pedicellariæ present .... *australis* var. *astrologorum*

cc. Abactinal and superomarginal plates not markedly convex. Pedicellariæ never occur .... *australis*

bb. Superomarginal plates 10 to 16 on each side .. . . *aurata*

aa. Terminal plate large, as big as, or bigger than any superomarginal ... . *queenslandensis*

Tosia australis Gray.

(Pl. xliii, figs. 10–13, Pl. xliv, fig. 6.)

Tosia australis Gray, Ann. Mag. Nat. Hist., vi, 1840, p. 281.

Astrogonium australe Müller and Troschel, Syst. Asteriden, 1842, p. 55.

Tosia australis Gray, Proc. Zool. Soc., 1847, p. 81.

Tosis australis Gray, Syn. Starfish Brit. Museum, 1866, p. 11, pl. 16, fig. 1.

Pentagonaster australis Perrier, Stell. Mus. d'Hist. Nat., Paris, 1875, p. 200 (and synonymy).

P. (*Tosia*) *australis* Tenison-Woods, Trans. Proc. Phil. Soc. Adelaide, S. Austr., 1879, p. 92.

Pentagonaster australis Bell, Proc. Linn. Soc. N. S. Wales, ix, pt. iii, 1884 (1885), p. 498.

Pentagonaster australis Sladen, Voy. "Challenger" Zool., xxx, 1889, pp. 266 and 745.

Tosia australis Verrill, Trans. Conn. Acad., x, i, 1899, pp. 148 and 160.

Tosia australis H. L. Clark, Rec. W. Austr. Mus., 1, pt. iii, 1914, p. 135.

Tosia australis H. L. Clark, Rec. S. Austr. Mus., iii, pt. iv, 1928, p. 381.

The marked variation in the actinal granulation of this species has been dealt with earlier in this paper.

Dr. Clark (*loc. cit.*) has clearly set out other varying characters relating to the plate system.

I believe Perrier (*loc. cit.*, p. 204) and Sladen (*loc. cit.*, pp. 744-5) to be in error when relegating Müller and Troschel's *Astrogonium australe* to the synonymy of *Tosia aurata*. Müller and Troschel, judging by their remarks, had *australis* before them and not *aurata*. Further, Gray (1866) evidently recognised the faithfulness of Müller and Troschel's identification when he included a reference to those authors under *australis*.

Material Examined:

5 specimens (R. = 20·5 mm. to 32·5 mm.), Victoria (Austr. Mus. Reg. Nos. J:3871-5).

5 specimens (R. = 14·5 mm. to 22 mm.), Reef at Portsea, Port Phillip, Victoria (Austr. Mus. Reg. No. J:4926).

4 specimens (R. = 12 mm. to 21·5 mm.), Westernport, Victoria (Austr. Mus. Reg. Nos. J:4214-7).

1 specimen (R. = 11·5 mm.), Lucky Bay, E. of Esperance, W. Austr. (Austr. Mus. Reg. No. J:3969).

2 specimens (R. = 10 mm., R. = 12·5 mm.), King George's Sound, W. Austr. (Austr. Mus. Reg. No. J:3982).

1 specimen (R. = 12·5 mm.), 3 miles south of Yellow Rock River, King Island, Bass Strait (Austr. Mus. Reg. No. J:4195).

2 specimens (R. = 12·5 mm., R. = 17 mm.), Currie Harbour, King Island, Bass Strait (Austr. Mus. Reg. Nos. J:4188-9).

4 specimens (R. = 10 mm. to 22·5 mm.), Tasmania (Austr. Mus. Reg. Nos. J:1242-5).

21 specimens (R. = 6·5 mm. to 20 mm.). Dredged 5 fathoms off Gordon, d'Entrecasteaux Channel, Tasmania (Austr. Mus. Reg. No. J:5428).

1 specimen (R. = 19 mm.), Tasmania (Austr. Mus. Reg. No. G:11308).

Distribution.—Victoria; King Island, Bass Strait; Tasmania; South Australia; Western Australia.

Tosia australis Gray var. **astrologorum** (Müller and Troschel).

(Pl. xliii, figs. 1–2.)

Astrogonium astrologorum Müller and Troschel, Syst. Asteriden, 1842, p. 54.

Pentagonaster astrologorum Perrier, Rev. Stell. Mus. d'Hist. Nat., Paris, 1875, p. 196 (and synonymy—? Perrier's reference to Gray ". . . Synopsis, p. 11", a direct dealing with *astrologorum* does not appear in Gray's paper; the name certainly does appear on p. 11, but only in the text matter under *Pentagonaster dübeni* Gray).

P. (*Tosia*) *astrologorum* Tenison-Woods, Trans. Proc. Phil. Soc., Adelaide, South Austr., 1879, p. 92.

? *Pentagonaster astrologorum* Sladen, Voy. "Challenger" Zool., xxx, 1889, p. 269.

? *Pentagonaster astrologorum* Whitelegge, Journ. Roy. Soc. N. S. Wales, xxiii, 2, 1889, p. 38.

Tosia astrologorum Verrill, Trans. Conn. Acad., x, i, 1899, p. 161.

Tosis australis var. *astrologorum* H. L. Clark, Rec. South Austr. Mus., iii, No. 4, 1928, pp. 381, 384.

The lowering of the status of *astrologorum* to varietal rank by Clark is fully justified in view of the evidence before me. Further, I am in complete accord with that authority when he states that "It is doubtful whether the use of even a varietal name is justifiable". However, it seems best to retain Müller and Troschel's name for specimens of *australis* which have swollen superomarginals until such time as the question can be settled, as Dr. Clark states, "at the shore and not in the museum".

Sladen (*loc. cit.*), who was followed by Whitelegge (*loc. cit.*), apparently made an error when he recorded *astrologorum* from "Sydney Harbour". The "species" has never been seen in Port Jackson (Sydney Harbour) since Sladen's record, a fact which is rather significant in view of the vast amount of collecting that has been done in the locality during the last forty years.

The specimens before Sladen when he made his record were, I believe, young specimens of *Pentagonaster dübeni* Gray, a variable sea-star fairly well represented in Port Jackson and a species which could easily have been confused with *astrologorum* by Sladen in the earlier days.

Material Examined:

1. specimen (R. = 29 mm.), on Reef at Portsea, Port Phillip, Victoria (Austr. Mus. Reg. No. J:4926).
1 specimen (R. = 30 mm.), Westernport, Victoria (Austr. Mus. Reg. No. J.4218).
1 specimen (R. = 30·5 mm.), dredged in 5 fathoms off Gordon, d'Entrecasteaux Channel, Tasmania (Austr. Mus. Reg. No. J:5428—part).
2 specimens (R. = 34 mm., R. = 36·5 mm.), Western Australia (Austr. Mus. Reg. No. G:11303).

Distribution.—Victoria; Tasmania; South Australia; Western Australia.

Tosia aurata Gray.

(Pl. xliii, figs. 3–9; Pl. xliv, fig. 8.)

Tosia aurata Gray, Proc. Zool. Soc., 1847, p. 80.

Tosis aurata Gray, Syn. Starfish Brit. Museum, 1866, p. 11, pl. xvi, fig. 2, *2a*.

Pentagonaster auratus Perrier, Rev. Stell. Mus. d'Hist. Nat., Paris, 1875, p. 204 (and synonymy in part).

P. (*Tosia*) *auratus* Tenison-Woods, Trans. Proc. Phil. Soc. Adelaide, South Austr., 1879, p. 92.

Tosia aurata Verrill, Trans. Conn. Acad., x, i, 1899, p. 161.

Pentagonaster (*Tosia*) *aurata* McCoy, Prodr. Zool. Victoria, dec. xx, 1890, p. 373, pl. 200, fig. 3.

Tosia aurata H. L. Clark, Biol. Res. F.I.S. "Endeavour", iv, 1916, p. 43.

The large number of superomarginals (10 to 16 on each side) serves as a ready guide to the identity of this species. Gray (1866) has made use of the actinal granulation to separate his species, including the present one, but I have pointed out elsewhere in this paper that this character is, for practical purposes, worthless. It is perhaps advisable to point out the differences seen in plates which are naturally naked and those which are rendered naked by accidental means. In the case of the former type the plates are invariably smooth and shiny, while in the case of the latter the plates are always rugged or pitted. This rugged character of plates, however, is quite different to the naturally rugged and faintly nodular appearance of abactinal plates of *T. queenslandensis*.

The resemblance of *aurata* to *T. grandis* Gray is very marked. It is known that in *aurata* the numerical range of the superomarginals is 10 to 16, and it is at once seen that the range embraces the number set out by Gray for *grandis*. It is clear, then, that the number of superomarginals in *grandis* is useless as a character distinguishing it from *aurata*.

The distribution of the actinal granulation in *grandis* as described by Gray applies also to variable specimens of *aurata*. The only remaining differences of possible value seem to be bound up in the following words from Gray's description: "Dorsal ossicula very unequal". From this, aided by Gray's figure, one infers that *grandis* lacks the central pentagon of large plates so characteristic of *aurata*, and that the abactinal plates are unusually unequal. A re-examination of Gray's type, however, seems to be the only way to clear away these uncertainties.

Sladen and Perrier include under this species as a synonym Müller and Troschel's (1842) *Astrogonium australe*. Such a course is, I believe, incorrect; the specimen before these latter authors had six superomarginal plates ("Sechs dorsale und acht ventrale Randplatten") which at once disassociates it from *aurata*.

Material Examined:

2 specimens (R. = 47 mm., R. = 44 mm.), Western Australia (Austr. Mus. Reg. No. G:11302).

2 specimens (R. = 54 mm., R. = 55 mm.), South Coast of South Australia, "Endeavour" Collection identified by H. L. Clark (Austr. Mus. Reg. Nos. J:1674, J:1677).

2 specimens (R. = 55 mm., R. = 68 mm.), Oyster Bay, Tasmania, 20–40 fathoms, "Endeavour" Coll., identified by H. L. Clark (Austr. Mus. Reg. Nos. J:1541-2, J:1544).

17 specimens (R. = 22 mm. to 44 mm.), dredged 5 fathoms off Gordon, d'Entrecasteaux Channel, Tasmania (Austr. Mus. Reg. Nos. J:5426-7).

43 specimens (R. = 27 mm. to 49 mm.), Simpson's Bay, d'Entrecasteaux Channel, Tasmania (Austr. Mus. Reg. No. J:5010).

1 specimen (R. = 45 mm.), Hobart, Tasmania (Austr. Mus. Reg. No. G:11301).

Distribution.—Victoria; Tasmania; South Australia; Western Australia.

Tosia tubercularis Gray.

(Pl. xliv, figs. 1–2, 7.)

Tosia tubercularis Gray, Proc. Zool. Soc., 1847, p. 91.

Tosia tubercularis Gray, Syn. Starfish Brit. Museum, 1866, p. 11, pl. 16, figs. 4–4*a*.

Pentagonaster minimus Perrier, Rev. Stell. Mus. d'Hist. Nat., Paris, 1875, p. 207.

P. (*Tosia*) *tubercularis* Tenison-Woods, Trans. Proc. Phil. Soc. Adelaide, S. Austr., 1879, p. 92.

Pentagonaster minimus Sladen, Voy. "Challenger" Zool., xxx, 1889, p. 266.

Pentagonaster tubercularis Sladen (*tom. cit.*), pp. 266, 748–9.

Description.—Rays five, body pentagonal. R. = 1·6 to 1·9 r. Interbrachial arc comparatively acute. Abactinal plates are numerous and collectively are unequal in size and shape. The largest plates occur as a pentagon on the centre of the disc. These plates are flat in young examples and only slightly convex in older specimens. The median radial plates and the adjoining series which run down to the tip of the ray are very noticeably swollen, particularly in small specimens. The plates in the area bounded by the central pentagon of large plates, are also noticeably swollen. The plates in the inter-radial areas on the abactinal

surface are for the most part only slightly convex; in young examples these plates are flat. Further, these plates are the largest on the abactinal surface with the exception of the plates forming the central pentagon. Every abactinal plate is bounded by a single row or series of granules. Papular pores occur singly on the abactinal surface.

The madreporite is inter-radial in position and lies next to one of the large plates forming the pentagon. It is triangular in shape with the three sides bulging out into a marked convexity.

The superomarginals range in number from six to eight; each is surrounded by a single row of granules. They are moderately swollen. In young specimens the superomarginals are of equal size excepting the ultimate which is conspicuously elongated and at least twice the size of any other superomarginal. In the largest specimens before me both the ultimate and the penultimate superomarginals are elongated and much bigger than any other superomarginal. In the largest specimen also is seen in one instance a fusion of an ultimate and a penultimate, the result being the formation of a plate of considerable size. The terminal plate is small and inconspicuous.

The inferomarginals number eight to ten. Like the superomarginals, each is separated by a single series of granules. Inferomarginals in young specimens are equal in size excepting the ultimate which is comparatively small. In older examples, particularly in the largest specimen before me, the antepenultimate is the largest plate in the inferomarginal series; the smallest is the ultimate as is seen in juvenile examples.

The plates of both marginal series are bare except for the single series of granules which surrounds each plate. Before passing on it is necessary to point out, in connection with the inferomarginals of the largest specimen, that there are indications of an additional plate at both ends of each series. This additional plate (if it can be called such), which is hardly more than an enlarged bald granule, is wedged between the ultimate plates of the marginal series and the terminal plate. Its presence is constant in every instance. If this plate is taken into consideration in the count of the inferomarginals, the range would be altered to eight to twelve and not eight to ten as previously stated. For the purposes of this description, however, these plates are not included in the range.

The actinal surface may be partially or wholly covered by coarse granules. Bivalved pedicellariæ with the appearance of split granules occur sparingly on the actinal surface. In most cases the pedicellaria is placed on a bare plate thus rendering its presence easily detected. The adambulacral armature is in four series, two on each side of the ambulacral groove. Each furrow comb is made up of two spines of equal size and length. Behind the furrow spines a second series occurs. This second series is made up of paired spines, the innermost spine of each pair being invariably the smaller both in size and height.

Remarks.—Apart from Gray's original description in 1847 and his redescription and figures which appeared in 1866, nothing of any interest has appeared regarding this species. A fact, however, which has led to a considerable amount of trouble is that Sladen (*loc. cit.*, p. 749) made an apparent reference to a record by Perrier which I have vainly spent much time in attempting to trace in the literature available to me.

Synonymy.—It is fairly clear that Perrier (*loc. cit.*) had *T. tubercularis* before him when describing his *Pentagonaster minimus*. The description applies so well to *tubercularis*, taking into consideration individual variation, that *minimus* must be placed as a synonym under *tubercularis*. The inclusion of "(E.P.)" after the name *Pentagonaster minimus* in Perrier's above cited work implies that there is an earlier reference to the species but no trace of such can be found in the literature available to me.

Material Examined:

8 specimens (R. = 11 mm. to 23·5 mm.), Port Fairy, Victoria (Austr. Mus. Reg. Nos. G:11309–10).

Distribution.—Western Australia and Victoria.

Tosia grandis Gray.

Tosia grandis Gray, Proc. Zool. Soc., 1847, p. 80.

Tosia grandis Gray, Synop. Starfish Brit. Museum, 1866, p. 11, pl. 3, fig. 1–1*a*.

P. (*Tosia*) *grandis* Tenison-Woods, Trans. Proc. Phil. Soc. Adelaide, South Austr., 1879, p. 92.

Tosia grandis Bell., Ann. Mag. Nat. Hist., (6), ii, 1888, p. 402.

The only record other than those of Gray which furthers our knowledge of this species is that of Bell (*loc. cit.*). That author's record, however, tells us nothing beyond the fact that his specimen or specimens came from Port Phillip, Victoria; no mention is made of the nature of the material examined, a fact which is to be regretted in view of the meagre information that existed, and still exists, concerning the species.

Taking the available information as a whole, a doubt cannot be suppressed concerning the validity of *grandis*. In no way can the species be satisfactorily separated from large specimens of *T. aurata*. Since Bell saw fit to retain the name it is perhaps best for the time being to allow it to stand until such time as a re-examination of Gray's type specimen is made.

Distribution.—Victoria and Western Australia.

Tosia rubra Gray.

Tosia rubra Gray, Proc. Zool. Soc., 1847, p. 81.

Tosia rubra Gray, Synop. Starfish Brit. Museum, 1866, p. 11, pl. xvi, figs. 3–3*a*.

P. (*Tosia*) *ruber* Tenison-Woods, Trans. Phil. Soc. Adelaide, South Austr., 1879, p. 92.

Like *grandis*, this species is very difficult to separate from *aurata*. The nature of the actinal granulation and the number and character of the marginals do not serve as a means of separation as was thought to be the case by Gray, therefore the only remaining character which may be useful is the convex nature of the abactinal plates. The information supplied by Gray in reference to this character is "Dorsal ossicula rather convex, rounded". This statement alone, however, does not convey much, as the reader has no means of deciding upon the degree of convexity.

The deepness of the convexity of the interbrachial arc would, at first thought, be considered useful as a basic character for the separation of *rubra* and

aurata, but it has been pointed out and illustrated elsewhere in this paper that the character is too variable to be useful.

The exact status of *rubra* can be settled only after a re-examination of Gray's type specimen.

Distribution.—Australia.

Tosia queenslandensis Livingstone.

(Pl. xliv, fig. 3.)

Tosia queenslandensis Livingstone, British Museum (Nat. Hist.), Great Barrier Reef Expedition, 1928-29, Sci. Reports, iv, No. 8, Asteroidea, 1932, p. 243, pl. v, figs. 1, 2, 7.

When this species and a young specimen of *Pentagonaster dübeni* Gray (see Pl. xliv, figs. 4–5) are compared three important points are at once recognizable. Firstly, the additional evidence of the intergradation of the species of *Tosia* with those of *Pentagonaster*. Secondly, the added difficulty of securing grounds to preserve these two genera, and, thirdly, the extremely close association of the two species themselves. The first two points I must be content merely to indicate at present, but the third can be dealt with here, taking into consideration the affinities of the two species and the means to be employed in their separation.

Both species possess large and conspicuous terminal plates, *queenslandensis* being the only species at present in *Tosia* in possession of such a character. The points of difference between the two species are as follows:

Pentagonaster dübeni Gray (juvenile specimen).	*Tosia queenslandensis* Livingstone (mature specimen).
1. The ultimate or penultimate superomarginal (in some rays both) always meets across the tip of the ray, being separated only by a double row of minute granules.	1. Neither the ultimate nor penultimate superomarginal ever meet across the tip of the ray. Both are always separated by one or more abactinal plates.
2. Body comparatively thin.	2. Body comparatively thick and robust.
3. R. = 18 mm., r. = 9 mm., R. = 2 r.	3. R. = 17 mm., r. = 10 mm., R. = 1·7 r.
4. Rays comparatively long and narrow.	4. Rays comparatively short and wide.
5. Abactinal plates bare and smooth.	5. Abactinal plates bare and nodular (or pitted), never smooth.
6. Granules separating abactinal plates flat and inconspicuous.	6. Granules separating abactinal plates are for the most part swollen, but always conspicuous.

Material Examined.—Specimens referred to in original description (*loc. cit.*).

Distribution.—Great Barrier Reef. Queensland.

EXPLANATION OF PLATES.

Plate XLIII.

Fig. 1.—*Tosia australis* Gray var. *astrologorum* (M. and Tr.). Abactinal surface of specimen from d'Entrecasteaux Channel, Tasmania (R. = 30·5 mm). (Austr. Mus. Reg. No. J: 5428 part.) Natural size.

Fig. 2.—*Tosia australis* Gray. var. *astrologorum* (M. and Tr.). Actinal surface of same specimen. Natural size.

Figs. 3-5.—*Tosia aurata* Gray. Abactinal surface of three specimens from Tasmania, all approximately of equal size, showing variation, particularly in the degree of acuteness of the interbrachial arc. (Austr. Mus. Reg. Nos. J: 5426; J: 1544. "Endeavour" specimen.) Slightly under half natural size.

Figs. 6-9.—*Tosia aurata* Gray. Actinal inter-radial areas selected from four specimens from d'Entrecasteaux Channel, Tasmania, to show variation in the granulation. (Austr. Mus. Reg. No. J: 5427 part.) Slightly over natural size.

Figs. 10-13.—*Tosia australis* Gray. Actinal inter-radial areas selected from four specimens from Tasmania to show variation in granulation. (Austr. Mus. Reg. No. J: 5428 part.) × 2.

PLATE XLIV.

Fig. 1.—*Tosia tubercularis* Gray (R. = 23·5 mm.). Actinal surface of specimen from Victoria. (Austr. Mus. Reg. No. G: 11309 part.) Slightly over natural size.

Fig. 2.—*Tosia tubercularis* Gray. Enlarged portion of actinal surface showing pedicellariæ. (Austr. Mus. Reg. No. G: 11309 part.) Approx. × 9.

Fig. 3.—*Tosia queenslandensis* Livingstone. Abactinal surface of holotype (R. = 17 mm.) showing differences between it and a juvenile specimen of *Pentagonaster dübeni* figured near by. (Austr. Mus. Reg. No. J: 5534.) Slightly under × 2.

Fig. 4.—*Pentagonaster dübeni* Gray. Abactinal surface of juvenile specimen from Port Jackson, N.S.W., showing affinities with, and differences from, *T. queenslandensis* Liv. (R. = 18 mm.). (Austr. Mus. Reg. No. J: 1820.) Slightly over natural size.

Fig. 5.—*Pentagonaster dübeni* Gray. Actinal surface of same specimen. Slightly over natural size.

Fig. 6.—*Tosia australis* Gray. Abactinal surface of specimen from Victoria (R. = 21·5 mm.). (Austr. Mus. Reg. No. J: 3871.) Natural size.

Fig. 7.—*Tosia tubercularis* Gray. Abactinal surface of same specimen as Fig. 1 Approx. × 1·3.

Fig. 8.—*Tosia aurata* Gray. Abactinal surface of specimen from d'Entrecasteaux Channel, Tasmania (R. = 28 mm.). (Austr. Mus. Reg. No. J: 5427 part.) Natural size.

PALÆONTOLOGICAL NOTES.

No. III.

The Skull of *Sthenurus occidentalis* Glauert.

By

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(Plates xlv-xlvi and Figures 1-6.)

In 1910 L. Glauert described this new species of *Sthenurus*, the type being a nearly complete mandible, with all the teeth in place, from the Mammoth Cave, Western Australia.[1] Later B. H. Woodward announced the discovery at the same place of two skulls of the new species, which, however, were not described.[2]

Being engaged on a revision of the macropod genera *Sthenurus* and *Procoptodon*, I desired to examine these skulls, and, on my communicating with Mr. Glauert, he very generously forwarded the two specimens for examination and description. I am also indebted to Mr. H. H. Scott,[3] Curator of the Queen Victoria Museum, Launceston, for the loan of a damaged skull from King Island, Tasmania, which supplements in an important manner the data obtained from the two Western Australian specimens. I am very grateful to these two gentlemen, and to the governing bodies of the Western Australian Museum and the Queen Victoria Museum for the privilege of examining the skulls, and also for their kind permission to extract the permanent premolar, which is of diagnostic importance.

It is unfortunate that the three skulls are those of comparatively young animals, though the chief features of the skull and of the maxillary teeth can be fully made out. In view of the paucity of even partially complete macropod skulls of Post-Tertiary age, these specimens are of great interest, particularly as the genus to which they belong differs somewhat from typical macropods in cranial and mandibular characters.

For purposes of description the larger skull from Western Australia will be referred to as A, the smaller B, while the Tasmanian specimen, which so strongly resembles the others that it may fairly be referred to the same species, will be distinguished as C.

The largest skull is nearly complete, but lacks the left zygomatic arch, part of the nasals, and the incisor teeth, only the roots of i^1 and i^2 being preserved;

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[1] Glauert.—Bull. Geol. Surv. W. Austr., 36, 1910, pp. 53-64; Rec. W. Austr. Mus., I, 1, 1910, pp. 31-36.

[2] Woodward.—Rec. W. Austr. Mus., I, 3, 1914, p. 252.

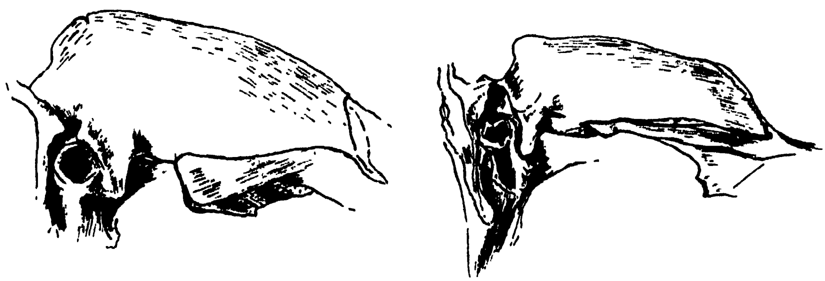
[3] Scott.—Memoir on *Procoptodon rapha*, Vict. Mus., Launceston, 1906; Brochure Mus. Launceston, No. 6, 1917, pp. 2-3.

in B (Pl. xlv, fig. 1), which is intermediate in size, the zygoma of the left side is missing, also the tips of the nasals, but the two lateral incisors are present on each side. In C (Pl. xlv, fig. 2) the brain case is lacking, but the nasals are practically complete and the three incisors of one side and i^1, i^2 of the other are fortunately preserved.

Skull.—This is remarkable for its shortness and depth (Pl. xlvi, fig. 2) and its generally robust character even in the young animal; in its proportions it has a resemblance to that of the Koalà, *Phascolarctus*. The facial portion and diastema are relatively much shorter than is usual in macropods living or extinct, although *Procoptodon*, of which, however, no skulls are known, resembles it in this respect. The dorsal profile is practically straight from the lambdoidal crest to the nasals, which are short, wide (their greatest breadth going about two and a half times in their length) and inflated, particularly in A and B. The naso-premaxillary suture is to the naso-maxillary (in C) approximately as 5 to 3. The naso-frontal suture curves evenly forwards from the median line. The frontal has no post-orbital process, but, particularly in B and C, overhangs the temporal fossa, the projection having a rather sharp edge. The interorbital space is practically flat in A and B, but shows a slight median concavity in C, the youngest individual. As one would expect in young animals, the intertemporal constriction is not marked.

The anterior palate has rounded edges and in A its least breadth is approximately three-fifths of the diastemal length; this proportion would, of course, be different in a fully adult animal. The incisive foramina are short, but extend backwards into the maxilla; the inter-alveolar[4] are situated nearly opposite the posterior ends of the incisive foramina. The palatal vacuities are large, extending forward level with or beyond the posterior lobe of p^4; as in recent forms the extent of these vacuities varies somewhat

The zygoma is deep and strong, the jugal extending backwards without diminution in depth until it reaches the glenoid fossa, which, viewed from the side, appears as a deep notch (Fig. 1) as in *Phascolarctus*; in recent macropods the jugal tapers posteriorly and reaches the shallow glenoid fossa as a thin splint, slightly thickened at the end (Fig. 2).



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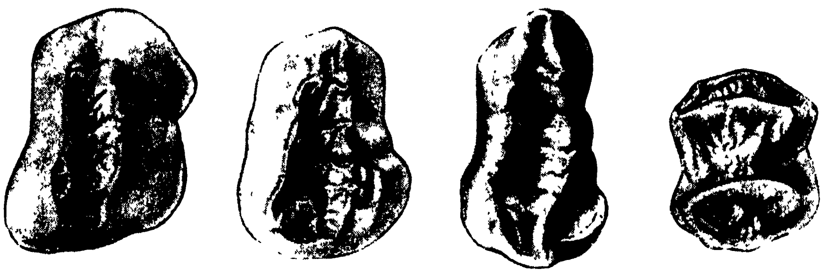
Figures 1-2.
Fig. 1.—Zygoma of *Sthenurus occidentalis* Glauert, Specimen A.
Fig. 2.—Zygoma of *Macropus giganteus*.
One-half natural size.

Miss J. Allan, *del.*

[4] Anderson.—Rec. Austr. Mus., XVII, 1, 1929, p. 36.

Dentition.—The Western Australian specimens have a complete set of juvenile cheek teeth on each side, though in B the last molar is not fully up; in C only the deciduous teeth and m^1–m^3 are present.

The median incisor is of moderate size, sub-cylindrical at the base and roughly triangular in section at the tip; it does not develop a cutting edge, but the termination is excavated by wear against the lower incisor. The second incisor is remarkable for its slenderness, especially in B; it is sub-triangular in section, expands slightly at the tip, and with i^3 forms a stop for the lower tooth. The third incisor is long antero-posteriorly, as in *Macropus giganteus*, compressed laterally, the anterior edge expanded somewhat medially; it has no vertical groove.



3 4 5 6

Figures 3-6.

Fig. 3.—*Sthenurus occidentalis*, fourth left upper premolar of Specimen A.
Fig. 4.—*Sthenurus occidentalis*; fourth left upper premolar of Specimen C.
Fig. 5.—*Sthenurus atlas* Owen; fourth left upper premolar (Aust. Mus. Reg. No. F.29556).
Fig. 6.—*Sthenurus occidentalis*; third upper molar of Specimen B.
Enlarged.

Miss J. Allan, *del.*

The deciduous premolar is stout and pear-shaped, wider posteriorly, and has one or two slight vertical grooves on each side near the middle, so that it shows a partial division into anterior and posterior lobes. The crown is worn in all the specimens, but it evidently has a shallow longitudinal depression. The permanent premolar (Figs. 3, 4) is a large strong tooth, almost rectangular in shape, though narrower in front. The crown is excavated longitudinally, but the depression is not deep and is filled with irregularly disposed but generally transverse ridges and folds, which in the centre do not rise as high as the side walls; they are more strongly developed on the external wall. There is a basal swelling in front, from which a groove runs to the crest, where it notches the front of the tooth and joins the longitudinal excavation. On the buccal aspect the base of the tooth bulges outwards and three or four vertical grooves notch the outer wall, which therefore has a denticulated crest. The inner wall is thinner, more even in outline, and slightly lower than the outer; the excavation is open to the rear. On the postero-external angle in B and C a small cusp is partially separated from the main body of the tooth. In general, the tooth has a strong resemblance to the permanent upper premolar of *Procoptodon goliah* Owen, though in the latter the postero-external cusp is more strongly developed.

The molars are short and wide, the lophs comparatively low, their crests thin and slightly concave backwards and downwards, the teeth being viewed in the prone position as figured (Pl. xlv, figs. 1, 2, and Fig. 6). The prebasal

ledge is narrow and bounded anteriorly by a low ridge which is a continuation of a fold which sweeps downwards from the external angle (paracone) of the anterior loph. In B and C, on the front of the anterior loph, somewhat medial to its middle point, another slight fold joins the loph to the prebasal ridge, and between these folds the front of the loph is traversed by a number of low folds or flutings, which in B extend on to the prebasal ledge. In A the central ridge is not developed and the flutings extend over practically the whole front of the loph, though they are less distinct on the medial third. There is no well-marked mid-link connecting the two lophs, but from the paracone a ridge extends towards the base, partially closing the mid-valley, and a less distinct ridge proceeds obliquely outwards from the protocone towards the base, crossing the mid-valley slightly medial to its middle point. The sub-triangular area thus defined shows a number of distinct branching folds, which also appear on the front of the hind loph, in which, however, the medial third is almost smooth. The posterior surface of the hind loph is occupied by a sub-triangular area bounded by two folds, which converge from the angles of the loph to meet and form a low crescentic ridge, or slight hind talon. Like the similar area on the posterior surface of the front loph, this is occupied by a series of branching folds and flutings.

Measurements made on the three skulls are here tabulated in millimetres; the breadth of the premolars was measured across the wider posterior portion, of molars across the anterior loph. Some measurements of the maxillary teeth of *Sthenurus atlas* Owen and *S. oreas* De Vis are included for comparison.

	A.	B.	C.	F.29556.	11204.
Basal length	173·0	152·0			
Height at m^3 (inclusive)	91·0	81·0			
Zygomatic breadth ..	136·0	115·0			
Nasals, greatest length (approximately) ..			48·0		
Nasals, greatest breadth		50·0	37·4		
Intertemporal Constriction	39·0	38·0			
Palate, greatest breadth outside m^3	60·2	58·4	52·0		
Palate, greatest breadth inside m^3	36·5	36·0	29·4		
Diastema	30·4	23·6	29·4		
Incisive foramen, length		12·0			
i^1, antero-posterior diam.			7·0		
i^2, antero-posterior diam.		3·5	4·0		
i^3, antero-posterior length		11·0	10·8		
p^3	10·5 × 10·0	10·8 × 9·9	10·2 × 9·6	10·0 × 8·0	
mp^4	10·0 × 9·5	10·0 × 9·6	10·0 × 9·4	10·4 × 8·5	
p^4	17·5 × 13·5	17·0 × 12·5	17·0 × 12·5	18·7 × 9·7	15·2 × 11·0
m^1	10·7 × 11·0	11·1 × 10·7	11·0 × 10·7	12·0 × 10·7	13·0 × 12·0
m^2	11·8 × 11·8	12·5 × 11·1	11·4 × 11·4	13·2 × 11·9	14·5 × 13·1
m^3	12·2 × 12·2	12·1 × 11·2	12·6 × 11·5	14·3 × 12·5	
m^4	11·8 × 11·7	11·8 × 10·9			
$m^1 - m^3$	34·7	35·7	35·0	39·5	

A, B, C: *Sthenurus occidentalis*.
F. 29556: *S. atlas*, Australian Museum.
11204: *S. oreas*, Queensland Museum.

The described species of *Sthenurus* consist of *S. atlas* Owen,[5] *S. oreas* De Vis,[6] *S. pales* De Vis,[7] and *S. occidentalis* Glauert. De Vis has united Owen's two

[5] Owen.—In Mitchell's "Three Expeditions into the Interior of Eastern Australia". II, 1838, p. 359 (*Macropus*).

[6] De Vis.—Proc. Linn. Soc. N.S.W., (2), X, 1894, p. 96.

[7] De Vis.—*Loc. cit.*, p. 94.

genera *Sthenurus* and *Procoptodon*,[8] but it is considered preferable to retain both at present, though undoubtedly they are closely related. All four species are based on mandibular specimens, but Lydekker has recognized upper jaw fragments of *S. atlas*,[9] and De Vis has on good grounds associated maxillary specimens with his type jaw of *S. oreas*. The teeth of *S. pales* (if this is indeed a *Sthenurus*) are so large and distinctive that it cannot be confused with any other, and there can be little doubt but that the skulls here described are those of *S. occidentalis*.

Lydekker states that in *Sthenurus* the molars have no vertical enamel folds and apparently this is true of the mandibular molars of *S. atlas*. In the Australian Museum there is a small number of maxillary specimens, which in other respects closely resemble *S. atlas* as described by Owen and Lydekker, and have no vertical flutings or puckerings on the molars, or only faint indications of these. In these specimens the fourth premolar is distinctly narrower than that of *S. occidentalis*, and the postero-external cusp is much more distinct, being separated by a deep cleft from the rest of the tooth (Fig. 5). In *S. atlas* the molars are larger, the lophs higher, and the ridge which joins the outer angle of the prebasal ridge to the anterior loph does not reach the crest of the paracone, but ends on the front of the loph, a little distance medial to the buccal margin.

To Mr. H. A. Longman, Director of the Queensland Museum, I am indebted for the loan of some examples of *S. oreas* named by De Vis. In this species the fourth upper premolar is similar in form to that of *S. occidentalis*, but smaller. The upper molars are about the same size as those of *S. atlas*, or slightly larger, but, like those of *S. occidentalis*, they show vertical folds and flutings.

EXPLANATION OF PLATES.

PLATE XLV.

Sthenurus occidentalis Glauert.

Fig. 1.—Skull; palatal view of Specimen B, Mammoth Cave, Western Australia About $\frac{3}{5}$ natural size.

Fig. 2.—Skull; palatal view of Specimen C, King Island, Tasmania. About $\frac{3}{5}$ natural size.

Fig. 3—Skull; lateral view of Specimen C About $\frac{3}{5}$ natural size.

PLATE XLVI.

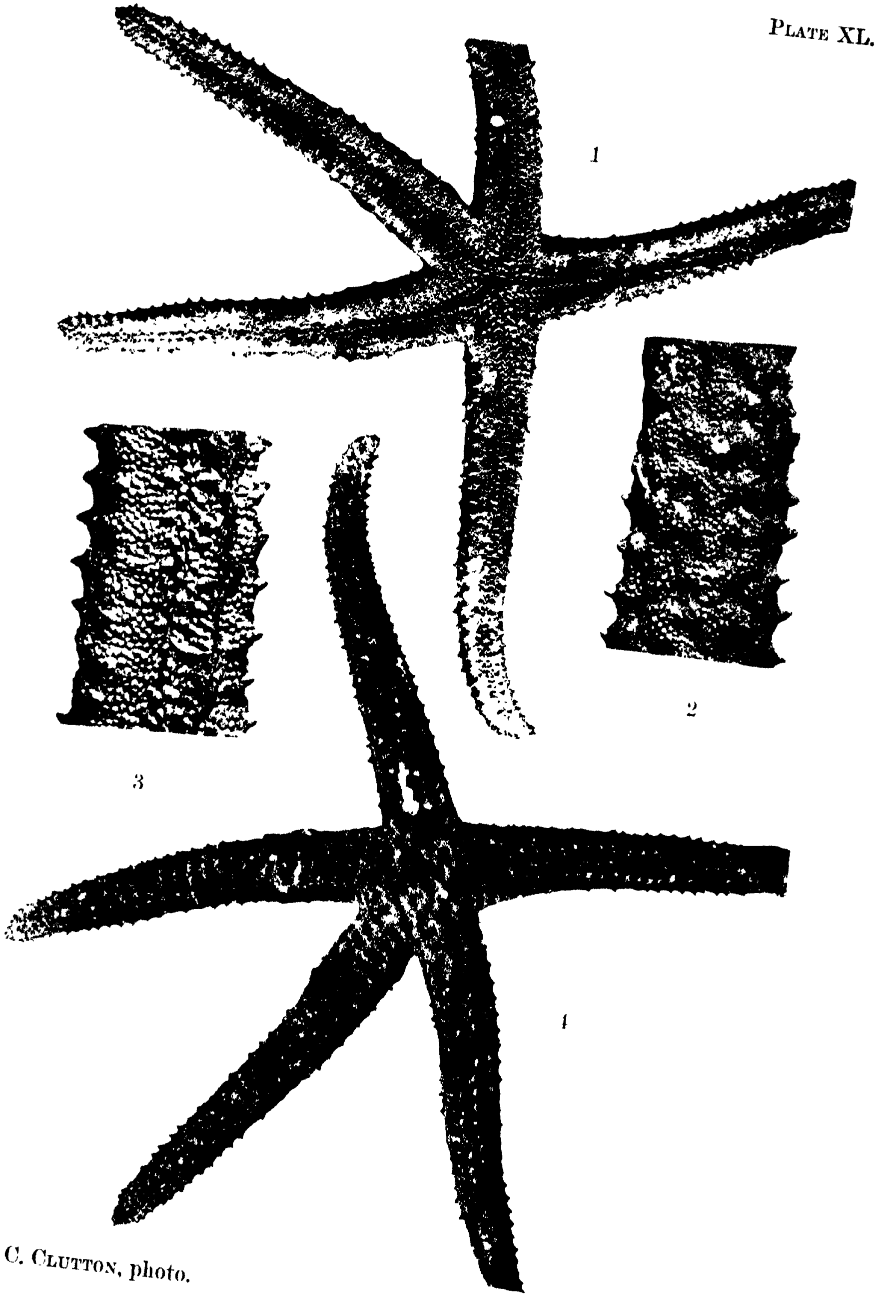
Sthenurus occidentalis Glauert.

Fig. 1.—Skull; top view of Specimen C, King Island, Tasmania. Natural size.

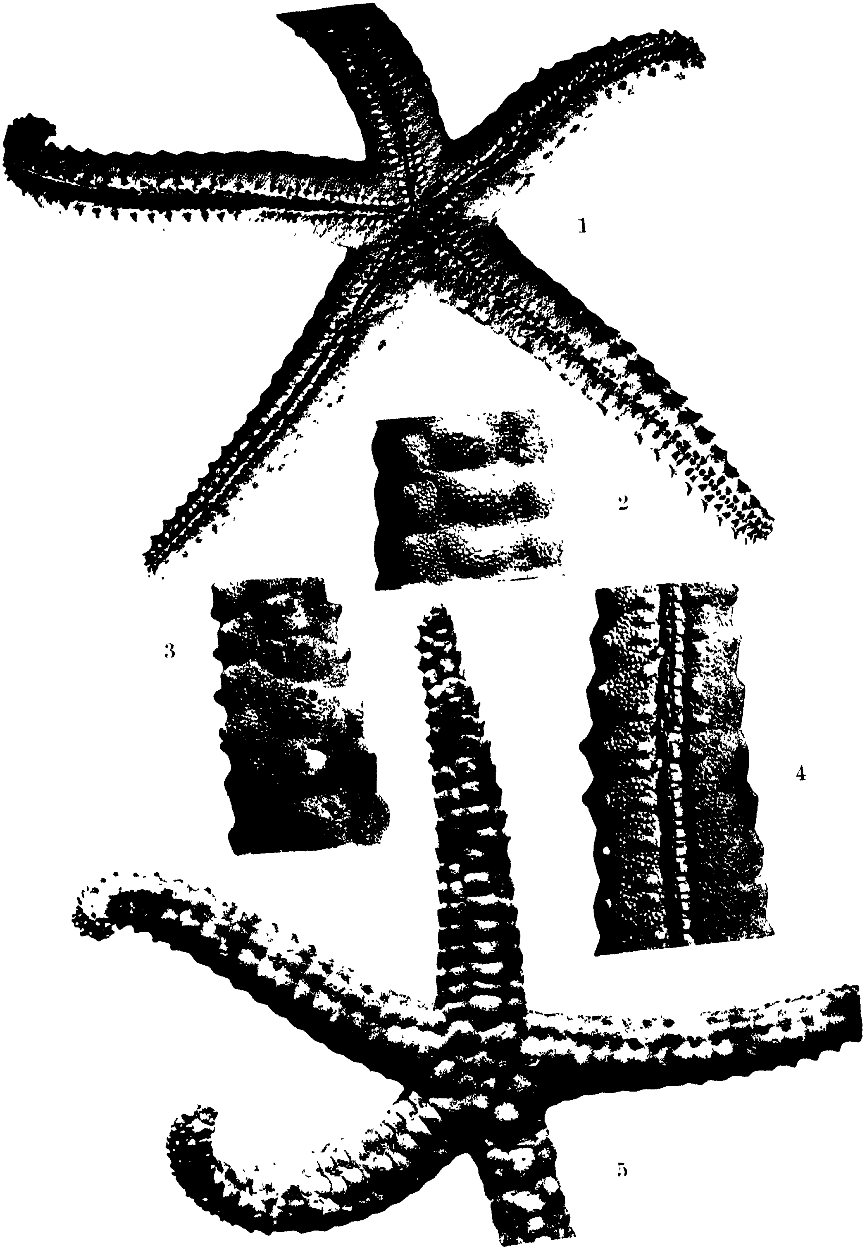
Fig. 2.—Skull and mandible. From casts of Specimen A and of type mandible. About $\frac{1}{2}$ natural size.

[8] De Vis.—*Loc. cit.*, pp. 88, 98.

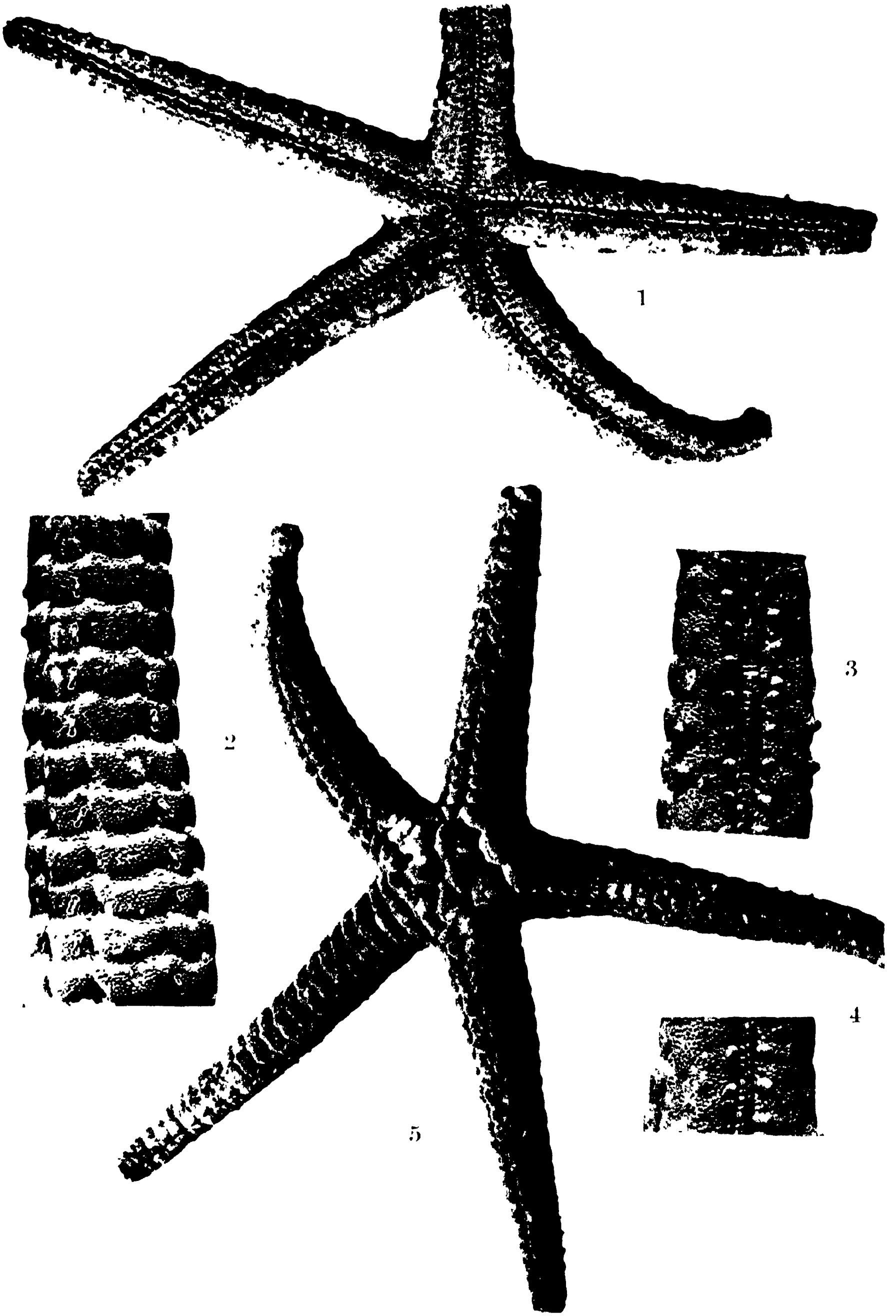
[9] Lydekker.—Brit. Mus. Cat. Foss. Mamms., Part V, 1887, p. 232.



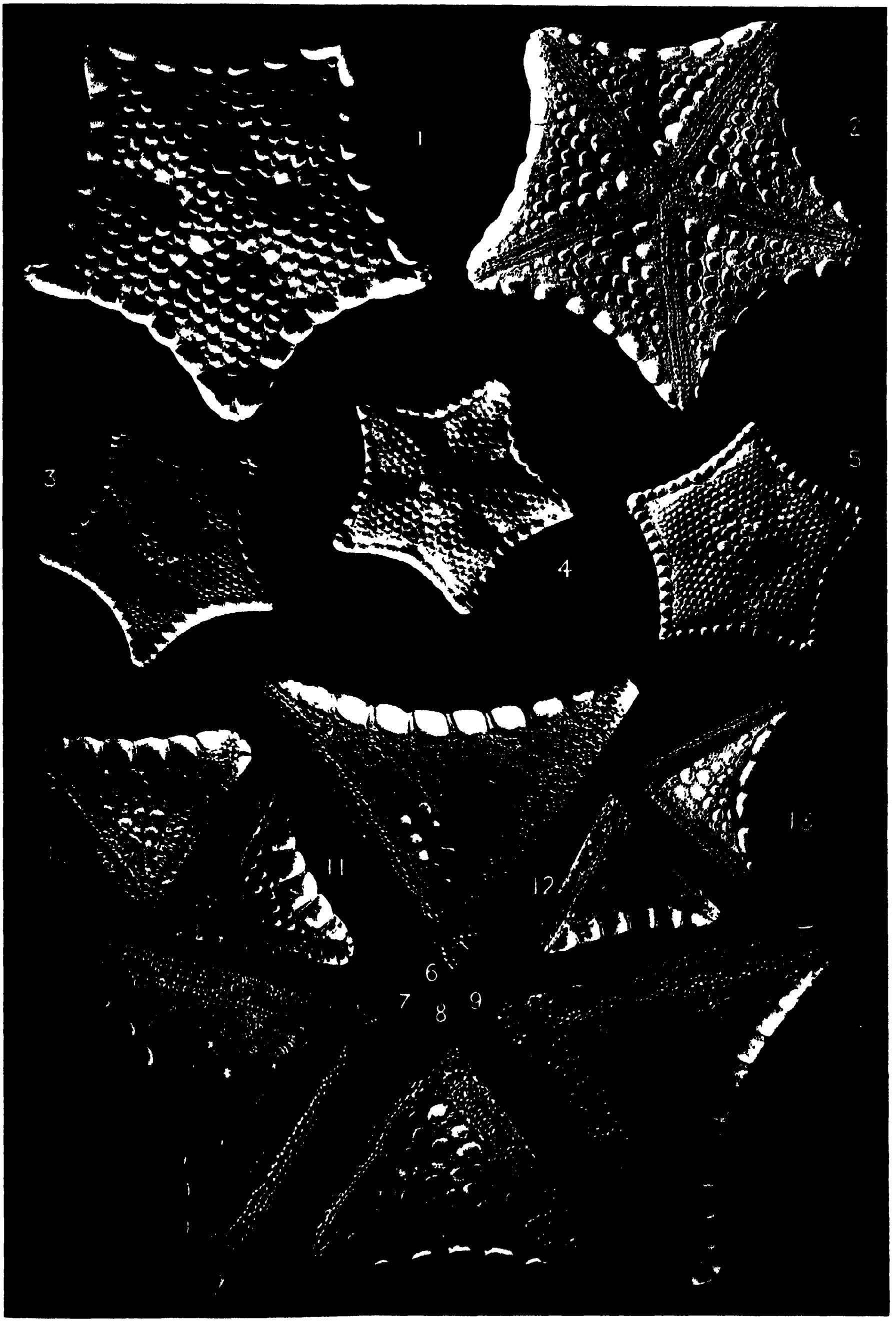
G. C. CLUTTON, photo.



G. C. CLUTTON, photo.



G. C. CLUTTON, photo.



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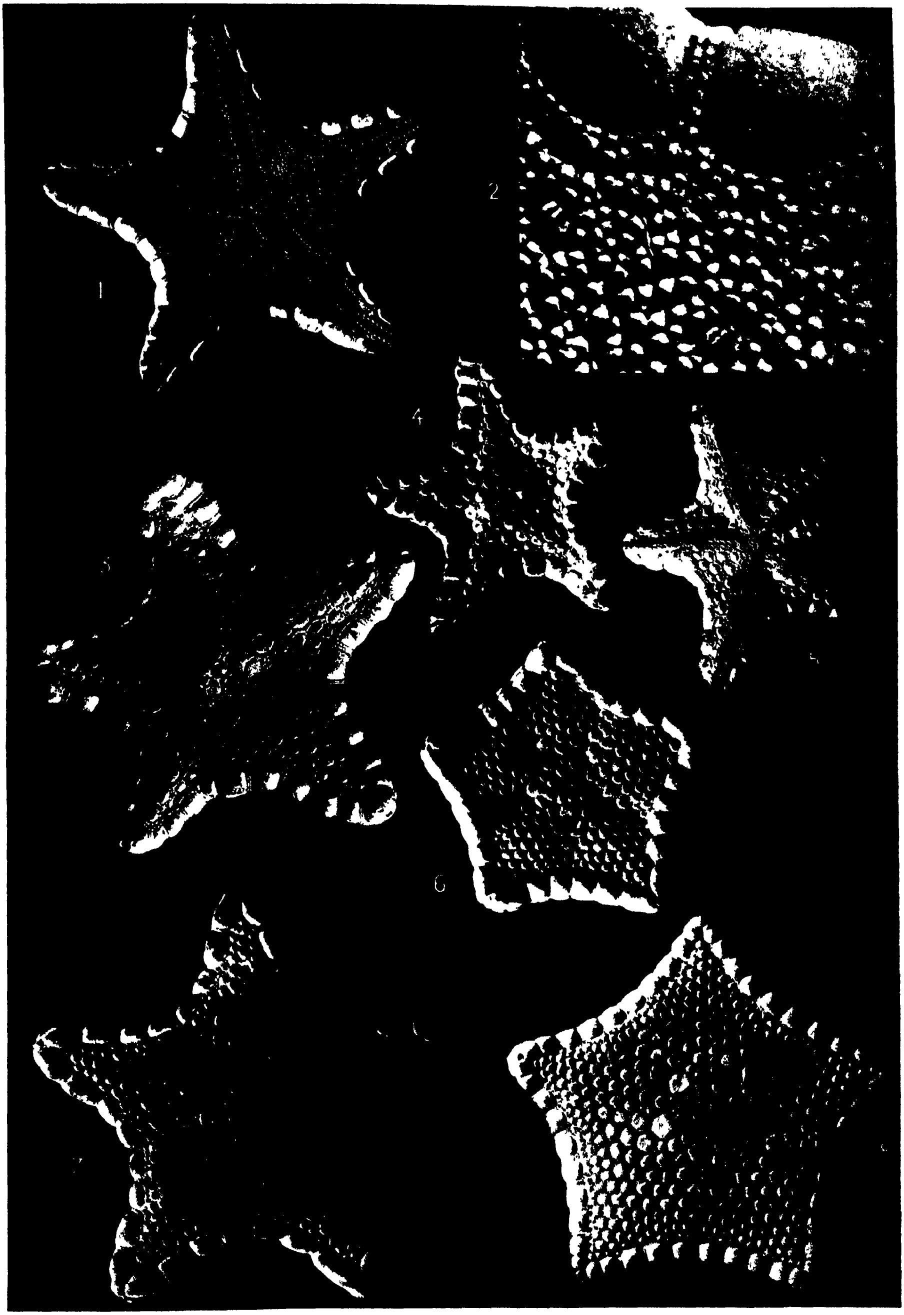

G. C. CLUTTON, photo.

G. C. CLUTTON, photo.

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G. C. CLUTTON, photo.

A REVISION OF THE GENUS *MYONIA*,[1] WITH NOTES ON ALLIED GENERA FROM THE PERMO-CARBONIFEROUS OF NEW SOUTH WALES.

By

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(Plates xlvii-l.)

INTRODUCTION.

A great deal of confusion exists over the status of many of our eastern Australian Permo-Carboniferous genera of Pelecypoda. This chaotic state is particularly pronounced in the genera described by J. D. Dana in 1847,[2] mainly *Cleobis*, *Cypricardia*, *Pyramus*, and *Myonia*, as well as other closely allied genera. Many of these forms were described from small series of not exceptionally well preserved specimens, and it is only to be expected that errors in synonymy, in a doubtful genus, will occur as time proceeds.

The Australian Museum collection of Permo-Carboniferous Pelecypoda has lately been augmented by the purchase of several large palæontological collections, consisting for the most part of the Varney Parkes and the John Mitchell collections, and these have considerably enhanced the working value of the collection on which this paper is based. This series, together with material and advice from Mr. W. S. Dun, Government Palæontologist of New South Wales and Lecturer in Palæontology at the University of Sydney, has enabled me to attempt to unravel these dubious* genera. The plaster casts or replicas of Dana's type specimens obtained by the Australian Museum from the United States National Museum, Washington, have also been of material assistance in the compilation of this work.

The genus *Mæonia*, changed from *Myonia* by the author in 1849, will have to revert to the original name given to it in 1847. Dana does not give any reason why this change in nomenclature was made, and as there appears to be no valid reason why the name should be changed, the genus must be known as *Myonia*.

The present paper deals with the various Upper Marine species of the genus *Myonia* (as laid down in this paper), but it has been found necessary to bring into the discussion many allied genera, previously placed as synonyms of *Myonia* or *vice versa*. These genera I hope to deal with as time permits and at no distant date. Mr. W. S. Dun for some considerable time past has devoted a good deal

[1] J. D. Dana.—Amer. Journn. Arts and Sciences (2), iv, Nov., 1847, p. 158.
[2] J. D. Dana.—*Loc. cit.*, pp. 151-160.

of attention and work to the Lower Marine fauna of the Permo-Carboniferous, and those species of *Myonia* which occur in these beds have been described by him, and published as an addition to the present paper.

STATUS AND AFFINITIES.

A series of specimens from the Illawarra district of New South Wales was described by J. D. Dana in November, 1847,[3] and included in these were three new genera which he described as *Cleobis*, *Pyramia*, and *Myonia*. The publication in which Dana's original descriptions appear is not available to all workers in palæontology, and, as these have an important bearing on the subject, I have included them in this paper. Dana's original description and observations of his genus *Cleobis* is as follows:

"Shell inequivalve, inequilateral, thick, transverse sub-ovate, closed (or nearly so). Beaks large, salient and incurved. Posterior margin broadly rounded and a little dilated. Ligament internal. Hinge line flexed to one side at middle and passing beneath the lower of the beaks. Valves thin. Surface marked unevenly with regular concentric striæ of growth and without radiations.—This genus appears to be near the *Ceromya* of Agassiz;[4] but of this we cannot be certain, as the palleal and muscular impressions are not visible. There is much external resemblance to the *Avicula cuneiformis* of Verneuil (Russia, pl. xli). The beaks are prominent and incurved, but are not flexed at all forward; they project over or overhang the cardinal line, the summit being separated from it by an intervening space. The valves are quite thin, the thickness being less than a line in a large species measuring seven inches in length."

Three species were described and placed in this genus by Dana: *Cleobis grandis*, *C. gracilis*, and *C.? recta*; all from the Illawarra district of New South Wales.

The genus *Pyramus* Dana describes as follows:

"Equivalve, somewhat inequilateral, transverse, elliptical, with the front and posterior margins nearly alike, entirely closed; beak somewhat prominent. Ligament external. Palleal impression entire, distant from the margin. Three muscular impressions to each valve, two anterior and one posterior; the larger anterior, suborbicular, smaller anterior, facing the same way with the larger, and situated just above its upper angle; posterior faint. Surface marked with concentric lines of growth. Cast of summit of beak a slender point. Shape nearly of *Donacilla* and *Sanguinolaria*, but it differs in its entire palleal impression and has also two anterior muscular impressions which belong together to each valve, as in *Corbis*. From the impression of the hinge of a left valve there appear to be no prominent teeth; it has a very oblique shallow sulcus, directed posteriorly from the centre of the hinge, and a slight excavation anterior to the centre. The form is more transverse and the teeth less distinct than in *Corbis*. It has not the long lunate muscular impression of *Lucina*."

Two species were described by Dana on page 157, namely *Pyramus ellipticus*, from Harper's Hill in the Maitland district (Lower Marine series), and *P. myiformis*, from Illawarra (Upper Marine series) of New South Wales.

The third genus described by Dana and the one with which this paper is more directly concerned is *Myonia*:

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[3] Dana.—Amer. Journ. Arts and Sciences (2), iv, Nov., 1847, pp. 151-160.

[4] Agassiz.—Études crit. Moll. foss. (2), 1842, 25.

"Shell thick, oblong transverse, inequivalve, very inequilateral, much gaping behind. Palleal impression strong, entire. Muscular impressions three to each valve; two anterior and one posterior, all excavate, smaller anterior on the front, posterior on the rounded carina between the flank and lateral surface. Valves thick. Lateral surface strongly flattened at middle or even concave.—Resembles much *Panopæa* and *Pholodomya*, especially Agassiz's *Arcomya*;[5] but differs in its entire palleal impression, its second anterior muscle, as well as other characters."

Two species were described as belonging to this genus, *Myonia elongata* and *M. valida*, both Upper Marine forms from the Illawarra district of New South Wales.

In May, 1848, J. D. Dana,[6] in a paper on fossil fish and a new belemnite, adds a footnote on species that McCoy had re-described in his paper[7] published several months after Dana's. In this note he states that *Notomya* of McCoy corresponds to *Pyramus* of Dana, but he cannot believe they are related to the *Myidæ* as stated by McCoy. Dana considers that his three genera make a natural group among the Astartidæ, as they have the smaller anterior muscular impressions facing in the same plane as the larger anterior. They differ strikingly from *Astarte*, *Pachydomus*, *Astartila*, and *Cardinia*, according to the author, and, moreover, the larger anterior is prolonged upward towards the smaller anterior muscular impression and is pointed.

Dana points out that *Myonia* possesses a second, small, anterior, muscular impression, situated high up on the beak, and that the group *Cleobis* is characterized by not having the sides at all excavate. He considers the generic characters not distinctive enough, and apparently is of the opinion that all these forms should be included in one genus.

In the following year (1849), Dana,[8] in his more extended account of the geology of the Wilkes' expedition, follows his plan of the preceding year and groups the two genera *Pyramus* (now *Pyramia*) and *Cleobis* with *Myonia*, but still points out that, as some of the differences are very striking, they may form subgenera. A definite opinion is left for others, for, beyond describing subgeneric characters, he places all the species concerned in the genus *Myonia*, the species of *Pyramia* and *Cleobis*, therefore, being included under *Myonia*. *Notomya* of McCoy,[9] Dana considers a synonym of his *Pyramia*, which is *Myonia*, and in justification of this step Dana explains that, although McCoy considers his genus to bear relationships with the *Myidæ*, its resemblance is only superficial in external form, as there is no true sinus to the pallial impression, and they also possess two anterior muscles.

A species of the genus *Pachydomus* of Morris,[10] described two years before Dana's first published report appeared, is now involved in the difficulties surrounding the genus *Myonia*. The specimen figured as *Pachydomus carinatus* (figure 4, plate xi) is placed as a synonym of *Cypricardia sinuosa*, described in Dana's first preliminary report on the fossils, but now itself placed as a

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[5] Dana.—*Loc. cit.*

[6] Dana.—Amer. Journ. Arts and Sciences (2), v, May, 1848, pp. 434-5.

[7] McCoy.—Ann. Mag. Nat. Hist., xx, 1847.

[8] Dana.—U. S. Explor. Exped. (Wilkes') Geology, x, 1849, pp. 695-698.

[9] McCoy.—Annals Mag. Nat. Hist., xx, 1847, pp. 303-4.

[10] Morris.—Strzelecki's Phys. Descrip. of N.S.W. and V. Diemen's Land, 1845, p. 273, Pl. xi, f. 3-4

synonym of *Myonia axinia*. The other figured specimen of *P. carinatus* (figure 3, plate xi), Dana places in his genus as *Myonia carinata*.

The species of the genus *Myonia* and their synonymy finalized in 1849 has been compiled as follows:

Myonia elongata Dana.

Myonia elongata Dana, Amer. Journ. Arts and Sci., (2), iv, Nov., 1847, p. 158.

Myonia valida Dana.

Myonia valida Dana, *loc. cit.*, p. 158.

Myonia axinia Dana.

Cypricardia ? sinuosa Dana, *loc. cit.*, p. 157.

Pachydomus carinatus Morris (pt.), Strzelecki's Phys. Desc. of N.S.W. and V. Diem. Land., 1845, p. 273, pl. xi, fig. 4 (not fig. 3).

Myonia ? carinata (J. Morris) Dana.

Pachydomus carinatus Morris (pt.), *loc. cit.*, pl. xi, fig. 3 (not fig. 4).

Cypricardia rugulosa Dana, Amer. Journ. Arts and Sci., (2), iv, Nov., 1847, p. 157.

Myonia fragilis Dana.

Myonia myiformis Dana.

Pyramus myiformis Dana, Amer. Journ. Arts and Sci., (2), iv, Nov., 1847, p. 157.

Myonia elliptica Dana.

Pyramus elliptica Dana, *loc. cit.*, p. 157.

Myonia gigas (McCoy) Dana.

Pachydomus gigas McCoy, Annals Mag. Nat. Hist., xx, 1847, p. 301, pl. xvi, fig. 3.

Myonia grandis Dana.

Cleobis grandis Dana, Amer. Journ. Arts and Sci., (2), iv, 1847, p. 154.

Pachydomus globosus ? Morris and McCoy.

Myonia gracilis Dana.

Cleobis gracilis Dana, *loc. cit.*, p. 154.

Myonia recta Dana.

Cleobis recta Dana, *loc. cit.*, p. 154.

In this list of species it will be seen that Dana includes all the species of his genus *Cypricardia* of 1847 (*non* 1849), *Cleobis* and *Pyramia* as synonyms of *Myonia*. *Notomya* of McCoy, said by Dana to be a synonym of his *Pyramia*, is not mentioned in his synonymy as far as the species are concerned, and, as Stoliczka[11] later says: "Dana, although stating that McCoy's *Notomya* is identical with his *Pyramia*, does not mention which of the species belong to each of the subgenera, and from the description and the figures the reader will find it very difficult to arrive at anything like accuracy of determination."

Dr. Stoliczka criticizes Dana's nomenclature, and says that: "Great confusion exists among the fossils which have been described from the New South Wales Palæozoic (Carboniferous ?) rocks, and some of the specimens described as *Notomya* or *Mæonia* may just as well belong to *Pachydomus* or *vice versa*."

[11] Stoliczka.—Cret. Fauna S. India, Pal. Indica., iii, 1871, p. 83.

A distinction between *Pachydomus cuneatus* and *Myonia axinia* of Dana cannot be recognized by Stoliczka, who also states that such species as *Myonia valida* and *Myonia grandis* or *gigas* very improbably belong to the same genus, as the first are strong *Crassatella*-like shells and the others thin *Homomya*-like shells, and that more likely they belong to altogether different families.

In discussing the status of the genera, he concludes that from the characters of the shells it seems impossible to class them in any other genus than *Notomya*, and that McCoy was correct in pointing out the similarity of those shells to the Myæ. McCoy's characteristics are far more intelligible than those given by Dana of his *Myonia*, and therefore he thinks it advisable to accept his name.

De Koninck in 1877[12] possessed two specimens which he identified as Dana's *Myonia myiformis*, and for these he created a new genus *Clarkia*, which he placed intermediate in position between *Panopæa* and *Glycimeris*. He states that he is obliged to do this, as the true *Myonia* are carinated forms, with simple pallial impression and two-hinge teeth. In the same work W. B. Clarke describes a non-carinate form as a new species of *Myonia*, calling it *M. konincki*. *Myonia elongata* and *M. gracilis* are described and figured in that genus, while the definitely carinated *Myonia ? carinata* of Dana is placed as a synonym of *Pleurophorus*.

R. Etheridge, junr., in 1878,[13] and again in 1880[14], offered a nomenclature as a temporary solution until some worker with a good series of specimens is able to throw more light on this question. Etheridge practically adopts Stoliczka's suggestion by accepting *Notomya* in preference to *Myonia* "because his description was more intelligible than Dana's and also because he correctly indicated the affinities of his genus". The species of *Myonia* are, according to Etheridge, now synonyms of *Notomya*, except *Myonia carinata*; this species is referred back to the genus *Pachydomus*.

The above nomenclature is followed eight years later by R. M. Johnston,[15] who dispenses altogether with the genus *Myonia*, placing all the species under *Notomya*, except *carinata*, which is still placed as a species of *Pachydomus*. *Mæonia konincki* of Clarke is referred to the genus *Pachydomus*, and *Clarkia myiformis* still persists as a good genus.

Etheridge, junr.,[16] in 1892, writing on this subject, states that the arrangement adopted in his earlier papers was a purely provisional one, proposed more as a temporary suggestion than an accurate solution of a difficult and obscure subject. This author now writes that "a further study of this subject has not ended in any very satisfactory result, as the material in the National Collection, London, although large, is not sufficient for the purpose in view. Added to this, the discrepancies between the various descriptions are so marked that it becomes impossible to adjudicate on the relation of the species referred to the genera in question. *Pachydomus* and *Notomya* will probably stand as good genera, certainly the former, and it is quite possible that it will be necessary to some extent to rehabilitate *Mæonia* of Dana."

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12 De Koninck.—Foss. Pal. Nouv-Galles du Sud, pt. 3, 1877, p. 283.
13 Etheridge, junr.—Cat. of Aust. Fossils, 1878, pp. 72-73.
14 Etheridge, junr.—Proc. R. Phys. Soc. Edinb., 1880, v, p. 300.
15 R. M. Johnston.—Geology of Tasmania, 1888, pp. 114-115.
16 Jack and Etheridge, junr.—Geol. and Pal. of Qld. and New Guinea, 1892, p. 282.

In re-establishing the genus *Mœonia*, Etheridge states that "this genus is provisionally used, pending a detailed examination of all those dubious Permo-Carboniferous bivalves, for shells after the type of *Mœonia elongata*". *Pachydomus carinatus* is placed as a synonym of *Mœonia carinata*, and in justification of this step Etheridge remarks that, although he formerly placed this species in *Pachydomus*, he now believes his reference and de Koninck's to the genus *Pleurophorus* to be erroneous, as the shell does not correspond with the original types of *Pachydomus*, such as *P. antiquatus* and *P. cuneatus*.[17] With regard to *Pleurophorus*, Etheridge says that he has quite failed to trace a dental structure in any casts of *M. carinata* examined, of which there are several good examples in the Australian Museum. *Myonia carinata*, in his opinion, is wholly devoid of hinge teeth, but possesses a peculiar system of muscle scars. These have been well figured by Felix Ratte,[18] showing double anterior and fringed muscle scars with accessory muscles at the apex of the beaks. These accord with the characters originally laid down by Dana for his genus *Mœonia*, and Ratte says: "I think it not improbable that this name will have to be retained for transversely elongate shells with the above characters typified by *Mœonia elongata* Dana and *Pachydomus carinatus* Morris."

Etheridge, junr.,[19] in 1919 described further specimens of these shells, strongly carinate and inflated types from the Lower Marine series of the Maitland district, New South Wales. *Mœonia morrisoni* and a small variety of *M. carinata* were described.

The presence of Australian generic forms in Carboniferous and Permo-Carboniferous beds beyond Australia has been referred to in a previous paper.[20] Other papers have since come to hand with new genera from North America and Brazil, which from a close examination of the figures and descriptions appear to be very closely allied to, if not identical with, some of our eastern Australian Permo-Carboniferous fauna. Several of these forms appear to have close affinities with the genus *Myonia*, and it is quite possible that several groups at present resting under various genera may have to be referred to the Myonidæ.

Faunal correlations at the present time are of particular interest and importance, and the discovery of a Permo-Carboniferous horizon in Brazil,[21] with a fauna having, according to Dr. Reed, nearest affinities with shells of the Lower and Upper Marine series of the Permo-Carboniferous of Australia, is of great interest.

The general fauna resembles markedly that of eastern Australia, but from the point of view of this paper interest lies mainly in two forms described as *Mœonia* cf. *cuneata* (Dana) and *Spathella tayoensis* Reed. Several species were relegated to *Spathella* by Hinde[22] in 1904 from the Carboniferous of England, and these with the Brazilian form may prove to have strong affinities with the Australian genus *Myonia*, although the muscle scars, according to Reed, appear to be a point of difference.

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[17] Sowerby.—Mitchell's Three Exped. into E. Aust., 1838, i, p. 15, pl. I, f. 2-3.
[18] Ratte.—Proc. Linn. Soc. of N.S.W. (2), ii, 1887, p. 139.
[19] Etheridge, junr.—Rec. Austr. Mus., xii, 1917-21, 9, p. 186, pls. xxviii-xxx.
[20] Fletcher.—Rec. Austr. Mus., xvii, 1, 1929, p. 2.
[21] Reed.—Monographias do Servico Geologico E Mineralogico do Brazil, x, 1930.
[22] Hinde.—Monograph of the Brit. Carb. Lamell., ii, 3, 1904, pp. 153-155.

Myonia cf. *cuneata* (Dana) described and figured by Reed appears to be certainly referable to the genus *Myonia*, and resembles very closely several species described in this paper from the Upper Marine series of the south coast of New South Wales. Before a definite opinion can be given on these relationships it is essential that specimens from these various localities be examined, and until these come to hand one can only venture suggestions from a close study of figures and descriptions.

A new genus of Pelecypoda which is closely allied to the Myonidæ is *Pleurophorella*, described by Girty[23] in June, 1904. This is a small strongly carinate type of shell from the Pennsylvanian rocks of Texas. Other genera from this locality have been compared with the Australian Permo-Carboniferous fauna, and it is quite possible that an interchange of specimens would prove these genera to have very strong affinities.

Summary of Conclusions.

After an exhaustive examination of a fine series of specimens and replicas of Dana's type specimens, together with his figures and descriptions, one can only conclude that there are three definite genera, as laid down by Dana in his preliminary report of 1847. The validity of these appeared doubtful to Dana, for in 1848 he reconsiders his characters of the previous year, and suggests that, if the characters he mentioned are not sufficient for generic distinction, they would probably be subgeneric. In 1849 Dana gives what he considers are his subgeneric characters, but, whether by accident or design, places all the species of his three genera in the genus *Mœonia*.

In my opinion, the subgeneric characters given by Dana, added to the shell proportions and outlines of these forms, which are entirely different, would form excellent generic differences and would make these three genera valid.

It is not my wish to go into details of other genera than *Myonia* in this paper, but at this stage I consider that *Cleobis* of Dana should be reserved for specimens after the type of the two original species, *C. grandis* and *C. gracilis*. These are comparatively large equivalve shells, very inequilateral, inflated and ovate. Beaks large, incurved, and hinge line overhanging. Posterior margin broadly rounded. No accessory anterior muscular scar. Lateral surface not compressed, but more or less bulging. Surface marked with coarse but regular concentric striæ or growth lines. Edentulous.

Cleobis recta referred to this genus is a doubtful species; it is a single specimen, not complete, and has been subjected to pressure which has caused distortion.

The consensus of opinion in regard to *Pyramia* is that it should be placed as a synonym of *Notomya* of McCoy, and this is also my contention. Dana, in 1848, in his note on genera re-described by McCoy, states that McCoy's article was published some months subsequent to his article on the same subject. According to the published dates, both papers appeared in print in November, 1847, but *Notomya* was selected to stand as it was better described and figured. According to the law of priority, *Pyramia* would become a synonym of *Notomya* in any case, as the genus was called *Pyramus* in 1847 and was changed to *Pyramia* in

[23] George H. Girty.—U. S. Nat. Mus., xxvii, 1904, p. 728, pl. xlv, figs. 4-6; pl. xlvi, fig. 5.

1848 by Dana. Dana states that these forms are similar to McCoy's specimens, and, according to his types, should be placed in the same genus as McCoy's *clavata* and *securiformis*.

The genus *Myonia* should, in my opinion, be reserved entirely for definitely carinated forms of large and small transversely elongated shells after the type of *Myonia elongata* of Dana and *Pachydomus carinata* of Morris. Dana, in 1848, was of the opinion that *Pachydomus gigas* of McCoy should fall into a group between *Cleobis* and *Myonia*, but this is only a large form of a carinated shell and is conformable to the description of *Myonia* without any modification of the generic distinctions.

Stoliczka and later Etheridge in his "Catalogue of Australian Fossils" were a little too sweeping in their change of nomenclature when referring all the species of *Mæonia* of 1849 to *Notomya* of McCoy, but no doubt this was a useful provisional method to adopt in keeping all the doubtful species together.

The genus *Clarkia* of de Koninck, created for his specimen of *Mæonia myiformis* of Dana, will no doubt be placed as a synonym of *Notomya* by some worker on that group, while *Mæonia konincki* of Clarke was referred to *Pachydomus*, its correct genus, by Johnston in 1888. *Pachydomus carinatus* of Morris is definitely one of the most characteristic forms of the genus *Myonia*, and is quite distinct from *Pleurophorus* and *Pachydomus*.

The nomenclature accepted in this paper is one more or less adopted by Etheridge in 1892, and includes the following as good and valid genera: *Cleobis* of Dana, 1847; *Pachydomus* of Morris, 1845; *Notomya* of McCoy, 1847, and *Mæonia* of Dana, 1847. These genera are well represented in the Australian Museum palæontological collection by an exceptionally well preserved series of specimens. This paper is the first of a series on these Permo-Carboniferous Pelecypoda and deals with the genus *Myonia*.

A list of the described species which have been referred to it is as follows: Species from the Upper Marine series, Permo-Carboniferous.

Myonia elongata Dana.
Myonia valida Dana.
Myonia carinata (Morris).
Myonia gigas (McCoy).
Myonia corrugata, sp. nov.
Myonia depressa, sp. nov.
Myonia accentuata, sp. nov.
Myonia minor Etheridge.
Myonia minor var. *etheridgei*, var. nov.
Myonia undata (Dana).

Order MYACEA.
Family SAXICAVIDÆ.[24]
Genus Myonia Dana, 1847.

Myonia Dana, Amer. Journ. Arts and Sci., (2), iv, 1847, p. 158.

Mæonia Dana, U. S. Explor. Exped. (Wilkes'), Geology, x, 1849, p. 604.

[24] Changed by Iredale to *Hiatellidæ*, Rec. Austr. Mus., xvii, 9, 1930, p. 406.

Generic Characters.—Shell definitely transversely elongated and variable in size, ranging from 45 mm. to 200 mm. Inequivalve; very inequilateral, the beaks situated in the anterior one-third to one-fourth of the shell. Shell inflated in posterior two-thirds of valves. Beaks (in casts) terminate sharply; more or less tumid in complete shell, recurved slightly posteriorly and overhanging hinge line. Shell may gape slightly at posterior extremity. Ligament strong, external. A well marked oblique sinus or depression originates at the base of the beaks and reaches the ventral margin, in many cases in the posterior half of the shell. At its junction with ventral margin a concavity is formed; ventral margin otherwise straight, rounded at extremities to form a rounded anterior margin and varying from a pointed to a rounded posterior extremity or margin. An oblique keel or carina originating at the apex of the beaks extends to the posterior extremity of the ventral margin. Carina always well defined, sharp or rolled, and dividing posterior two-thirds of valve into two portions. The larger lateral portion usually strongly convex; a smaller dorsal portion, flattened and rising slightly towards junction of valves to form ligamental ridge. Anterior third of valves compressed.

Muscular impressions usually three to each valve, two anterior and one posterior; occasionally in some species two posterior, all excavate. Larger anterior adductor muscular impression is oval to diamond-shaped, being pointed above and only slightly pointed below. The inner surface of the larger muscle scars definitely fringed. Small anterior accessory muscle scar, situated above larger anterior, both facing the same way, towards the beaks. Posterior muscle scar large and oval. A smaller posterior muscle scar is sometimes visible in juxtaposition. Pallial line entire, extending from anterior to posterior scars, without sinus, and some distance from ventral margin. Hinge line small, straight. Edentulous.

The shell ornamentation or sculpturing usually consists of well-marked, fairly even, concentric striæ or growth lines. These follow the shell outline and at the carina form almost a right angle to cross the flattened postero-dorsal surface. Internal casts have a nodulose flank, the surface above the pallial line being covered with irregular tubercles. Smooth below pallial line. Shell comparatively thick.

Observations.—The main distinction of the species of the genus *Myonia* is the presence in all of the definitely marked ridge or carina, and the oblique sinus which separates the valve into a more or less compressed anterior one-third to one-fourth, and an inflated or swollen posterior portion. The affinities of this genus have been somewhat in doubt, as Dana in 1847 placed *Myonia* in close affinity with forms belonging to the family Anatinidæ, order Myacea. In 1848 the same author referred it to the Astartidæ, order Lucinacea. Stoliczka, *loc. cit.*, places this group as *Notomya* of McCoy in the family Saxicavidæ, order Myacea. Etheridge, later re-establishing the genus *Mæonia*, follows Stoliczka's classification and places it in the Saxicavidæ. If these shells are to be referred to this order they will have to form a group in which the valves are only slightly gaping posteriorly, in which the pallial line is continuous, and a sinus does not occur. At the present stage it is advisable to leave the genus in its present classification.

Myonia elongata Dana.

(Plate xlvii, figures 1–3.)

Myonia elongata Dana, Amer. Journ. Arts and Sci., (2), iv, 1847, p. 158.

Mœonia elongata Id., U. S. Explor. Exped. (Wilkes') Geol., x, 1849, p. 695, pl. v, fig. 3.

Description.—J. D. Dana, in his preliminary report in 1847, gives the following original description of this species:

"Thick, right valve rather the larger; greatest height half the length; gradually narrowing behind the beak, inferior margin just posterior to middle somewhat concave, carina from beak to posterior angle broadly rounded, not bent; flank flat, cardinal area long and circumscribed; surface strongly marked unevenly with regular striæ of growth. Length 6¾ inches; height 53/100ths L.; thickness 42/100ths L.; anterior part about half the posterior; apical angle 145°. Illawarra."

This is the type species of the genus. It is an unmistakable form, and is represented in the Australian Museum collection by a very fine series from which additional characters have been secured.

Shell twice as long as high, transversely elongated, equivalve and inequilateral, the beaks situated in the anterior one-fourth of the shell. Upper and lower valve margins subparallel. Beaks definite, slightly recurved posteriorly and overhanging the hinge line. Hinge line straight and short. A definite and distinct ridge or carina originates at the apex of the umbone and extends obliquely to the posterior extremity of the valve. On internal casts the ridge is sharp, on testiferous specimens slightly rolled. A sinus or depression arises at base of umbo and extends very obliquely to the inferior margin. At junction the margin is incurved slightly, making a slight concavity on the otherwise straight ventral margin. Posterior two-thirds of shell inflated, the inflation beginning at the sinus and extending towards the umbonal ridge, at which point the shell attains its maximum width. Dorsally the shell area between the ridge or carina and the valve junction is flattened, rising slightly to form a ligamental ridge at the junction. Pallial line thick and entire.

Muscular impressions on well preserved specimens show one large posterior and three anterior scars. The large anterior scar is rounded dorsally and pointed below, extending to a small accessory muscle scar. A second, small, rounded, accessory adductor scar is situated above the larger and in juxtaposition with it. The posterior adductor muscle scar is situated on the flattened postero-dorsal slope of the shell; large and oval. Inner edge of superior anterior muscle scar is heavily fringed.

Shell ornamentation or sculpture is not a strong feature, consisting of closely packed striæ or growth lines. Test comparatively thick. Surface of internal casts in many specimens nodulose above the pallial line, smooth below. Edentulous.

Dimensions.—

	Plate xlvii.		
	Fig. 1. (F.8232.)	Fig. 2. (L.669.)	Fig. 3. (F.21716.)
Length	198 mm.	155 mm.	161 mm.
Height	84 mm.	86 mm.	88 mm.
Angle of ridge	25°	30°	30°
Width (both valves)	87 mm.	69 mm.	88 mm.

Observations.—This species is restricted to the Upper Marine series, all the known specimens having been collected from the Illawarra district, south coast of New South Wales. A certain amount of variety is noticeable in a large series of specimens, due more to distortion and stresses during preservation than to varietal differences in the shell itself. De Koninck[35] described a form from the red sandstone at Wollongong, south coast of New South Wales, which he decided was *M. elongata.* This specimen agrees with a series described as *M. accentuata* in this paper, and has been placed as a synonym. This form differs from *M. elongata* in the sharp and pointed posterior extremity and the straight umbonal ridge. The members of the group as a whole are smaller than *M. elongata.*

Localities.—Bundanoon Gully, Wollongong, Gerringong, Kiama, Kioloa, Jamberoo, and Black Head, all in the Illawarra district of New South Wales.

Horizon.—Upper Marine series, Permo-Carboniferous.

Figured specimens.—Australian Museum collection.

Collection.—Australian Museum and Mining Museum, Sydney.

Myonia valida Dana.

(Plate xlviii, figures 1–3.)

Myonia valida Dana, Amer. Journ. Arts and Sci., (2), iv, 1847, p. 158.

Mœonia valida, *idem*, U. S. Explor. Exped. (Wilkes') Geol., x, 1849, p. 695, pl. 5, fig. 3.

Description.—The only description of this species to my knowledge is the original one by Dana, and is as follows:

"Thick, very inequilateral, oblong, length somewhat less twice the height, rather rapidly decreasing in height posteriorly, and obliquely truncate behind, strongly carinate, with the flank (in cast) flat and broad and bent at the posterior muscular impression. Left valve slightly highest. Sides obliquely excavate, inferior margin excavate. Large muscular impressions with strong vertical erosions; the larger anterior produced upward nearly to the smaller anterior. Accessory muscular impression on front of beak. Palleal impression very strong, with delicate vermiform erosions running upward from it, and others (attachment of muscular fibres) scattered over the lateral surface. Length of cast 6 inches; height 58/100ths L.; thickness 45/100ths L.; apical angle of cast 120°."

This species has the general form of *M. elongata* Dana, but is a much blunter form, the greatest height being less than half the length. The oblique sinus which arises at the base of the umbone is very definite (particularly in the casts), and at its junction with the inferior margin forms a deep excavation. Posterior two-thirds of shell blunt and inflated, anterior one-third more or less compressed. The characteristic ridge or carination, extending from the apex of the umbone to the posterior extremity of shell, is conspicuous and arched. The ridge bends at the posterior muscle scar and meets the inferior margin at a comparatively steep angle.

The anterior muscular impression is large and oval, extended dorsally towards a smaller accessory muscle scar, rectangular in shape. Posterior scar large and oval, situated mainly on the flattened postero-dorsal slope, but with a slight extension on the flank of the shell. A smaller posterior muscle scar is situated

[35] De Koninck.—Foss. Pal. Nouv-Galles du Sud, pt. 3, 1877, p. 142, pl. xx, fig. 6.

a little above the main scar, oval in shape. Muscle scars are directed towards umbones. Scars heavily striated. Pallial line thick and entire, situated well in from the inferior margin. Flank of casts nodulose as in the above species, smooth below the pallial line.

Ornamentation of test consists of fine closely packed striæ with occasional heavy folds or growth lines.

Dimensions.—

	Plate xlviii.		
	Fig. 1. (F.8206.)	Fig. 2. (F.2096.)	Fig. 3. (L.657.)
Length	142 mm.	137 mm.	146 mm.
Height	87 mm.	82 mm.	92 mm.
Angle of ridge	35°	35°	35°
Width (both valves)	78 mm.	64 mm.	67 mm.

Observations.—This species was originally described from a single cast of this species and to my knowledge has not been mentioned in literature since 1849. A small series of exceptionally fine specimens is represented in the Australian Museum collection, including both internal casts and testiferous shells. It is a particularly characteristic form and easily distinguished by its blunt appearance, high flanks, and by the beaks being situated in the anterior one-third of the shell. It resembles *M. elongata* of Dana to a certain extent, but may be easily separated by the above characters, and the fact that the ridge is decidedly curved. Its height in relation to length is also a distinctive feature in this species.

Localities.—Black Head; Kiama; Flagstaff Hill, Wollongong; Illawarra district, south coast of New South Wales.

Horizon.—Upper Marine series, Permo-Carboniferous.

Figured specimens.—Australian Museum collection.

Collection.—Australian Museum and Mining Museum, Sydney.

Myonia accentuata, sp. nov.
(Plate xlvii, figures 4–5.)

Mæonia elongata de Koninck (not *elongata* Dana), Foss. Pal. Nouv-Galles du Sud, pt. 3, 1877, p. 142, pl. xx, fig. 6.

Description.—Shell of comparatively large size, transversely elongated and from twice to two and a half times as long as high. Equivalve; strongly inequilateral, the umbones situated in the anterior one-fourth of the valves. Hinge line straight and not of great length. Valves greatly convex, particularly inflated in the posterior portion, gradually diminishing towards the anterior margin, which is more or less compressed. A sinus or groove arises at the base of the umbone and excavates the shell obliquely towards the ventral margin. At its point of junction with the inferior margin a concavity breaks the otherwise straight margin. The posterior extremity of shell sharp and pointed; anterior margin rounded. Beaks blunt, pointing posteriorly and overhanging the hinge line. Originating at the apex of the umbone a ridge or carina extends at a low angle to the posterior extremity of the valve, terminating in practically a point. Ridge is exceptionally sharp and distinct, dividing the shell at its most inflated part into two areas, a lateral convex area and a flattened postero-dorsal area. At the valve

junction the shell rises to form a ligamental ridge. Shell slightly gaping at posterior margin. On flattened surface of shell a second subsidiary carina or swelling begins from the posterior end of the escutcheon. Shell material thin.

The ornamentation or shell sculpture consists of fine concentric striæ superimposed on coarser growth lines. Absence of internal casts prevents the elucidation of the musculature system.

Dimensions.—

	Plate xlvii. Fig. 4. (F.1118.)		Plate xlvii. Fig. 5. (F.2472.)
Length	133 mm.	..	161 mm.
Height	62 mm.	..	63 mm.
Angle of ridge	—	..	20°
Width (both valves)	74 mm.	..	65 mm.

Observations.—This species is represented by a series of four specimens which form a definite type. De Koninck's[26] specimen figured and described as *M. elongata* of Dana has been placed as a synonym of this species, as it agrees in all details. The extreme sharpness of the posterior extremity and its length in comparison with height makes this an outstanding form. *M. elongata* and *M. valida* of Dana are the only two species of the genus which resemble it in any way, and these are easily separated by the following major characters:

(1) *M. elongata* and *M. valida* have a rounded posterior extremity, whereas in *M. accentuata* the posterior extremity is sharp and pointed.

(2) In *M. accentuata* the umbonal ridge is straight; in *M. valida* is arched strongly near the inferior margin, and in *M. elongata* is slightly concave.

(3) Shell proportions are entirely different. *M. accentuata* is a grossly elongated type; *M. valida* is a little longer than high, and *M. elongata* is twice as long as high.

Localities.—Gerringong Cliffs and Conjola, Illawarra district of New South Wales.

Figured Specimens.—F.2472 holotype (Mining Museum, Sydney), F.1118 paratype (Australian Museum Collection, Sydney).

Collection.—Australian Museum and Mining Museum, Sydney.

Horizon.—Upper Marine series, Permo-Carboniferous.

Myonia carinata (J. Morris).

(Plate xlix, figures 1–3.)

Pachydomus carinatus Morris, Strzelecki's Phys. Desc. of N.S.W. and V.D. Land, 1845, p. 273, pl. xi, fig. 3 (not fig. 4).

Cypricardia rugulosa Dana, Amer. Journ. Arts and Sci., (2), iv, 1847, p. 157.

Pachydomus carinatus McCoy, Ann. Mag. Nat. Hist., xx, 1847, p. 301.

Mæonia ? carinata Dana, U. S. Explor. Exped. (Wilkes'), Geology, x, p. 696, atlas, pl. 6, fig. 1.

Pleurophorus ? carinatus de Koninck, Foss. Pal. Nouv-Galles du Sud, pt. 3, 1877, p. 283, pl. 19, fig. 8.

Pachydomus ? carinatus Etheridge, Proc. Roy. Phys. Soc. Edin., vi, 1880, p. 300, t. 16, f. 53.

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[26] De Koninck.—Foss. Pal. Nouv-Galles du Sud, pt. 3, 1877, p. 142, pl. xx, fig. 6.

Notomya (*Mœonia*) *elongata* Ratte (*non* Dana), Proc. Linn. Soc. N.S.W., ii, 1, 1887, p. 139, pl. 3.

Mœonia carinata Jack and Etheridge, Geol. and Pal. of Qld. and New Guinea, 1892, p. 283.

Description.—This is a transversely elongate shell, comparatively oval and convex. Beaks situated in the anterior one-third of the valve, recurved slightly posteriorly. Anterior margin of shell rounded, merging with the convex inferior margin; posterior wedge-shaped to rounded. An oblique sinus or depression originates at apex of umbones and extends to the ventral margin, which is incurved at the junction to form a concavity. This depression divides the shell into two portions, an anterior one-third, compressed, and a posterior two-thirds, inflated but not strongly. A strongly marked umbonal ridge arises at the umbone and extends to the posterior extremity at a very oblique angle. Postero-dorsal slope, between ridge and ligament, slightly flattened. Hinge line straight and short. Ligament external. Inferior margin arcuate, almost straight.

Muscular impressions excavate. Anterior adductor muscle scars two in number, consisting of a large oval scar, fringed on the inside, and a smaller accessory scar situated dorsally. Posterior muscle scar situated on postero-dorsal surface. Above the larger scar a small muscle scar is in juxtaposition. Pallial line thick and entire, uniting the two larger scars, situated a good distance from the inferior margin. Internal casts nodulose on the flanks above the pallial line.

Dimensions.—

	Plate xlix.		
	Fig. 1. (F.13840.)	Fig. 2. (F.2471.)	Fig. 3. (L.660.)
Length	98 mm.	87 mm.	62 mm.
Height	61 mm.	46 mm.	40 mm.
Width (both valves)	—	31 mm.	—
Angle of ridge	35°	34°	35°

Observations.—This is an unmistakable and one of the most characteristic species of the genus *Myonia*. It was first described by Morris in 1845 as a species of *Pachydomus* and later placed in its correct genus by Dana in 1849. Since then it has been placed in more genera than any other species of the genus. The strongly marked carination, particularly in internal casts, makes this form easily recognizable. It is represented in the Australian Museum by a large series of well-preserved specimens from the Upper Marine series, showing perfect musculature and testiferous shells showing ornamentation. This consists of concentric striæ, fine and closely packed, with occasional heavier folds. This species resembles *M. valida* to a certain extent, but differs in the smaller size and flattened flanks. The beaks are also not situated so far anteriorly. The distinct sharp carination is also characteristic.

Localities.—Illawarra district, Wollongong, Wandrawandian, Bundanoon, Gerringong, Jamberoo, Burrier, Shoalhaven River, south coast of New South Wales; Branxton, Maitland district. Coral Creek, Bowen River below Sonoma Road Crossing, Queensland. Port Arthur, Tasmania.

Horizon.—Middle or Marine series, Bowen River Coal Field, and Upper Marine series, Permo-Carboniferous.

Figured specimens.—F.2471, Mining Museum collection; L.660 and F.13840, Australian Museum collection, Sydney.

Collections.—Australian Museum and Mining Museum, Sydney.

Myonia gigas (McCoy) Dana.

(Plate xlix, figure 7).

Pachydomus gigas McCoy, Ann. Mag. Nat. Hist., xx, 1847, p. 301, pl. xvi, fig. 3.

Mæonia gigas (McCoy) Dana, U. S. Explor. Exped. (Wilkes'), Geology, x, 1849, p. 697.

Pachydomus gigas (McCoy), de Koninck, Foss. Pal. Nouv-Galles du Sud, pt. 3, 1877, p. 136.

Description.—Shell large, half again as long as high, very inequilateral, equivalve. Umbones situated in the anterior one-fourth of the valve. Shell compressed with wide flanks. Shallow sinus originates on the surface of umbone and extends obliquely to the inferior margin, where it joins with a slight concavity on the margin. Anterior margin of valve rounded and compressed. Posterior margin rounded and slightly inflated; greatest inflation posterior to the umbones; inferior margin straight. Umbonal ridge or carination is distinct but not sharp, extending obliquely and slightly arching towards posterior extremity, where it merges with valve.

Shell surface comparatively smooth, ornamentation consisting of fine concentric striæ with heavier growth folds or ridges.

Dimensions.—

	Plate xlix. Fig. 7. (F.30224.)	F.2468.	L.1421. (McCoy's type.) Cast.
Length	191 mm.	157 mm.	145 mm.
Height	108 mm.	96 mm.	102 mm.
Angle of ridge	55°	45°	—
Width (single valve)	35 mm.	38 mm.	84 mm.

Observations.—In the original description of this species McCoy mentions its great width in proportion to length; the flattened compressed sides of the posterior slopes; the oblique truncation of the posterior end, and the smallness and narrowed appearance of its anterior end. Dana in his description of 1849 mentions that a carina is present but not distinct, and places it as a synonym of his *Mæonia*. De Koninck in 1877 places this species in the genus *Pachydomus*, with no mention of a carina in his specimen, but says it was in a very bad state of preservation and did not allow him to give any of its characteristics or even dimensions.

According to a plaster cast of McCoy's type specimen, the shell is inflated, with convex to flattened flanks. A ridge or carina is present, and is arched as in *M. valida* of Dana. The postero-dorsal slopes are narrow and flattened, rising at the junction of the valves to form a ligamental ridge. A deep lunule is present with a shallower escutcheon. The flank excavation is narrow and shallow.

This species is quite unlike any other species of the genus on account of its large size, shallow sinus, and height in relation to length.

Localities.—Jamberoo, Wollongong, south coast of New South Wales.

Horizon.—Upper Marine series, Permo-Carboniferous.

Figured specimens.—Australian Museum collection.

Collection.—Australian Museum, Sydney.

Myonia corrugata, sp. nov.

(Plate l, figures 3-4.)

Description.—Shell of large size, not exceeding 160 mm. Transversely oval, very convex and heavy. Equivalve and extremely inequilateral; umbones situated very anteriorly, the apex of the umbones almost projecting beyond the anterior margin. Beaks recurved anteriorly and overhanging hinge line. Anterior margin rounded; internal casts show deep concavity between apex of the umbones and the anterior adductor scar, which is raised considerably from the valve. Valve flanks very inflated, with a slight sinus originating on the flattened surface of the umbone and extending almost parallel with ridge to the inferior margin, where a slight concavity at the junction breaks the otherwise straight margin. Posterior margin spatulate, extensive, and rounded, wider than anterior portion of valve. A distinct and heavy umbonal ridge or carina originates at the apex of the umbone and extends to the inferior margin, not quite to the posterior extremity.

Musculature system consists of two anterior and one posterior scar. The large anterior adductor muscle scar is roughly diamond-shaped, directed in same general direction as umbones. Raised some distance from valve on internal casts. A smaller anterior adductor muscle scar is situated above the large scar and is attached by a prolongation of the most dorsal point of the large adductor scar. Posterior adductor muscle scar large, situated on the wide flattened postero-dorsal slope. Pallial line thick and deeply marked; entire, uniting both large scars.

Shell ornamentation or sculpturing consists of heavy concentric striæ, widely spaced and sharp.

Dimensions.—

	Plate l. Fig. 3. (F.30014.)	Plate l. Fig. 4. (F.2478.)	F.2469.
Length	132 mm.	133 mm.	160 mm.
Height	77 mm.	76 mm.	111 mm.
Width (both valves)..	26 mm.*	—	43 mm.
Angle of ridge	42°	45°	50°

Observations.—This most peculiar species of the genus is quite unlike any other. It is a form of the Upper Marine series and one that cannot be mistaken.

The following characters make it easily distinguishable:

(1) Extreme inequilateral outline of the shell.

(2) Large and raised anterior adductor muscle scar on the internal casts.

(3) Extreme convexity and heaviness of shell.

(4) Broad rounded posterior margin, large postero-dorsal slopes and heavy ornamentation unlike that of any other species.

Localities.—Millfield, Wyro, near Ulladulla, Conjola, south coast of New South Wales.

Horizon.—Upper Marine series, Permo-Carboniferous.

Figured specimens.—F.30014 (Holotype), Australian Museum collection; F.2478 (Paratype), Mining Museum, Sydney.

Collection.—Australian Museum and Mining Museum, Sydney.

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* Single valve.

Myonia depressa, sp. nov.

(Plate xlviii, figures 4–5).

Description.—Shell (without umbones) more or less oval in outline, the anterior margin being rounded similarly to the posterior margin. Inequivalve and inequilateral, the umbones situated in the anterior one-third of the valve. Umbones flattened but prominent, slightly overhanging hinge line. Hinge line short and straight. Umbones recurved slightly pointing posteriorly. Inferior margin straight, slightly arcuate in the median position. A wide and distinct sinus originates at base of umbone and extends obliquely to the ventral margin. Lateral slopes of flanks of valve flattened and compressed, being uniformly convex at posterior and anterior ends. A definite ridge or carina extends obliquely from the apex of the umbones and extends to the posterior extremity, where it merges with the shell. Sculpture or shell ornamentation consists of flattened striæ or growth ridges, following the shell outline.

Dimensions.—

	Plate xlviii. Fig. 4. (F.30314.)		Plate xlviii. Fig. 5. (F.2466.)		F.21731.
Length	123 mm.	..	150 mm.	..	131 mm.
Height	70 mm.	..	80 mm.	..	74 mm.
Width (both valves)..	24 mm.	..	—	..	22 mm.
Angle of ridge	40°	..	42°	..	40°

Observations.—This species is represented by a comparatively large series of specimens from the Illawarra district of New South Wales. The majority are from the Upper Marine sandstones at Kioloa and Termeil, and as a result the preservation is not exceptionally good and no internal casts are represented. Its oval outline, compressed lateral slopes and the shell sculpturing make this form unmistakable.

Localities.—New South Wales: Bundanoon; Kioloa; Termeil; Ulladulla; Gerringong; Illawarra district.

Horizon.—Upper Marine series, Permo-Carboniferous.

Figured specimens.—F.2466 (Holotype), Mining Museum collection; F.30314 (Paratype), Australian Museum collection.

Collection.—Australian Museum and Mining Museum, Sydney.

Myonia minor Etheridge fil.

(Plate xlix, figures 4–6; Plate xlviii, figures 6–7.)

Mæonia fragilis Dana (pt.), U. S. Explor. Exped. (Wilkes'), Geology, 1849, pp. 696–7; atlas, pl. vi, fig. 3.

Mæonia carinata Morris var. *minor* Etheridge, REC. AUST. MUSEUM, xii, 9, 1919, p. 187, pl. xxix, figs. 5–8.

Description.—Shell of comparatively small size, not exceeding 58 mm.; transversely sub-oblong, equivalve and inequilateral. Length half again as long as high. Umbones highest points of shells, pointed, directed posteriorly and overhanging hinge line. Hinge line straight and short. Valves convex on flanks, becoming strongly inflated posteriorly and slightly compressed anteriorly. Umbonal ridge or carina exceptionally distinct, strong and sharp. Originates at the extreme apex of umbone and extends obliquely to the posterior inferior extremity. Posterior

portion of shell wedge-shaped; anterior portion rounded. Inferior margin of shell gently rounded; a shallow median sinus extends from base of umbone to the ventral margin, where a slight concavity marks the junction. Lunule small and deep; escutcheon distinct, deep and elongate. Musculature not shown on specimens.

Surface ornamentation of valves consists of wide lamellæ or growth ridges, with fine indistinct concentric striæ superimposed.

Dimensions.—

	Plate xlix.			Plate xlviii.
	Fig. 4. (F.13939.)	Fig. 5. (L.661.)	Fig. 6. (F.30223.)	Fig. 6. (F.30313.)
Length	57 mm.	48 mm.	58 mm.	33 mm.
Height	31 mm.	29 mm.	35 mm.	16 mm.
Width (both valves)	11 mm.*	—	18 mm.	12 mm.
Angle of ridge	42°	42°	40°	30°

Observations.—This Upper Marine form of *Myonia* is the smallest in the series. Originally described by Etheridge as a variety of *M. carinata* Morris, but as a further series of specimens show no digression in size or characters, I have elevated the variety to specific rank. *Mæonia fragilis* Dana (part) has been placed as a synonym of this species. Dana in his atlas[27] figured two specimens, a large specimen (Plate vi, figure 2), and a smaller specimen (figure 3). A plaster cast or replica of figure 3 is in the Museum collection and agrees in every detail with the present species, as far as exhibited characters are concerned, but it is by no means a perfect specimen. Dana in his description of *M. fragilis* gives the dimensions of a comparatively large shell, more than twice the size of the specimen (Plate xlix, figure 4, of this paper) now placed as a synonym of *M. minor.* The rounded posterior margin of the small specimen and the arched ventral margin do not agree with the description of *M. fragilis.*

The extreme angle of the ridge in this species gives the shell a short or "stumpy" appearance, which, together with its small size, makes it an easily recognizable form.

Included with this species is a small series of specimens after the style of the two figured on Plate xlviii, figures 6 and 7. These are exceptionally well preserved specimens of testiferous valves which appear to compare well with *Pleurophorella papillosa* of Girty[28] from the Pennsylvanian rocks of Texas. The description and figures of this species agree perfectly with this smaller series of specimens, and I have no doubt that they must have strong affinities. No internal casts are in the collection, so that the musculature and other internal structures cannot be described. In its smooth test and ornamentation this form differs from the typical species. Fine concentric striæ are very numerous, many of the striæ on the flanks being sinuate. Larger flattened lamellæ or growth ridges, uneven and few in number. A further series of the small form may prove it to be a definite species, but at present owing to lack of material it must be placed with *M. minor.*

* Single valve.

[27] Dana.—U. S. Explor. Exped. (Wilkes') Geology, 1849, x, p. 696; atlas, pl. vi, figs. 2-3.

[28] Girty.—Proc. U. S. Nat. Mus., xxvii, 1904, p. 728, pl. xlv, figs. 4-6; pl. xlvi, fig. 5.

Localities.—New South Wales: Wandrawandian and Burrier, south coast; Bundanoon Gully, S.W. of Sydney; Glendon.

Horizon.—Upper Marine series, Permo-Carboniferous.

Figured specimens.—Australian Museum collection.

Collection.—Australian Museum, Sydney.

Myonia minor Etheridge fil. var. etheridgei, var. nov.

Mœonia carinata Morris var. *minor* Eth., junr., Rec. Aust. Museum, xii, 1919, pl. xxx, fig. 9.

Description.—Shell transversely elongate, wedge-shaped; pointed posteriorly and more than twice as long as high. Anterior margin rounded. Dorsal margin and inferior margin parallel in the central two-thirds of valve. Umbones highest point of shell, broad and pointed, overhanging hinge line; incurved and situated in the anterior one-fourth of the shell. Escutcheon well marked and elongate. Lunule shallow. Valves moderately convex, becoming inflated at posterior extremity. A median depression or sinus extends from the base of the umbone to centre of the ventral margin. Umbonal ridge or carina strong and very sharp, extending in a gentle curve from the apex of the umbone to the extreme posterior extremity, completing the wedge-shape of the valve. Postero-dorsal slopes between the umbonal ridge and hinge line inclined steeply towards valve junction to form ligamental ridge. Hinge line straight and short.

Surface of shell covered with broad concentric ridges or growth lines and finer concentric striæ.

Dimensions.—

	F.13929.
Length	56 mm.
Height	24 mm.
Width (both valves)	18 mm.
Angle of ridge	24°

Observations.—This variety is represented in the collection by a single specimen of both valves collected at Bundanoon Gully, about ninety miles S.W. of Sydney. It was figured by Etheridge[29] as a sub-variety of *M. carinata* var. *minor* ?. No mention was made in the text of this specimen, but in the explanation of plates we read: "Possibly a sub-variety, narrower and more elongate." This specimen, which is beautifully preserved, showing no sign of distortion, is a unique form amongst the smaller species of the genus. Its extremely elongated shell, the curve of the umbonal ridge, and the wedge-shaped posterior extremity, suffice to make this variety unmistakable.

Locality.—Bundanoon Gully, N.S.W.

Horizon.—Upper Marine series, Permo-Carboniferous.

Collection.—Australian Museum, Sydney.

Myonia undata (Dana).

(Plate 1, figures 1–2.)

Pholadomya undata Dana, Amer. Journ. Arts and Sci., (2), iv, Nov., 1847, p. 153.

Pholadomya (Platymya) undata Dana, U. S. Explor. Exped. (Wilkes'), Geology, x, 1849, p. 687.

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[29] Etheridge, junr.—Rec. Austr. Mus., xii, 1917-21, 9, pl. xxx, fig. 9.

Description.—Shell of medium size, transversely oval, obliquely gibbose, inequilateral and almost twice as long as high. Equivalve; valves slightly inflated in median line and becoming compressed towards valve extremities. Umbones distinct, slightly raised and placed forward on the anterior one-fourth of the valve. Anterior of umbone short and narrow, with rounded margin except on umbonal slope, which is straight. Posterior two-thirds of shell has a truncate or bluntly rounded extremity. Dorsal margin straight; inferior margin rounded. Hinge line straight and short. A sinus or well developed excavation extends obliquely from the umbone to the inferior margin. A ridge or carination extends from the apex of the umbones to the posterior extremity. Ridge is distinct on complete testiferous shells, but becomes rather rounded on internal casts. Postero-dorsal surface flattened, comparatively wide. Escutcheon well developed and elongate. Muscle scars slightly excavate.

Dimensions.—

	Plate 1. Fig. 1. (L.631.)		Plate 1. Fig. 2. (F.1127.)		F.21713.
Length	76 mm.	..	69 mm.	..	61 mm.
Height	42 mm.	..	37 mm.	..	31 mm.
Width (single valve)..	11 mm.	..	10 mm.	..	9 mm.
Angle of ridge	30°	..	30°	..	30°

Observations.—The specimen figured in Plate 1, figure 2, is a cast of one of Dana's types, which is at present housed in the United States National Museum, Washington. This specimen from Wollongong Point, Illawarra, was described by Dana in 1847[30] as *Pholadomya undata*, and later in 1849[31] in his more complete work as *Pholadomya (Platymya) undata*. Dana states in his observations that "the palleal impression is not seen on the specimens in the collections, of this, or either of the three following species, and we cannot say whether it has a sinus or not. We suspect the latter, in which case the species are not Pholadomyæ, and may be nearer the Mæoniæ." Additional specimens in the Australian Museum collection do not show the musculature markings, but all other characters appear to point very strongly to the Myoniæ, in which genus it has been placed. The definite sinus on the flanks of the shell and the ridge or carination and flattened postero-dorsal slopes leave little doubt that it is a *Myonia*.

Dr. F. R. Cowper Reed, in describing Permo-Carboniferous fossils from Brazil,[32] compares a single specimen with *Cardinia ? cuneata* (Dana),[33] and de Koninck's figure of *Mœonia elongata*.[34] An examination of the figure and Reed's description of *Mœonia* cf. *cuneata* (Dana), leads me to the conclusion that his specimen has more affinities with *Mœonia undata* (Dana) than with any other species of the genus. *Mœonia elongata* Dana (relegated to *Mœonia accentuata*) is a more or less inflated type, with a sharp posterior extremity, and is more than twice as large as the Brazilian form. *Cardinia ? cuneata* Dana, referred provisionally to the genus *Stutchburia* by

[30] Dana.—Amer. Journ. Arts and Sci. (2), iv, Nov., 1847, p. 153.

[31] Dana.—U. S. Explor. Exped. (Wilkes') Geology, x, 1849, p. 687; atlas, pl. ii, fig. 11.

[32] Reed.—Monographias do Servico Geologico E Mineralogico do Brazil, x, 1930, p. 37, pl. vi.

[33] Dana.—Amer. Journ. Arts and Sci., iv, 1847, p. 158; *idem.*, fig. 6. U. S. Explor. Exped. (Wilkes') Geology, x, 1849, p. 695, pl. v, figs. 3*a*-*c*.

[34] De Koninck.—Foss. Pal. Nouv-Galles du Sud, 1877, 3, p. 142, pl. xx, fig. 6.

Etheridge,[35] does not possess an umbonal ridge, and from the figures published by him does not possess any strong affinities with *Mæonia* cf. *cuneata* described by Reed. From the general description, *M. undata* has many points in common with Reed's specimen, particularly in the shell dimensions and the presence of a straight umbonal ridge running from the umbone to the posterior extremity.

Localities.—New South Wales: Wollongong Point; Gerringong; Illawarra district.

Horizon.—Upper Marine series, Permo-Carboniferous.

Figured specimens.—Australian Museum collection, Sydney.

Myonia fragilis Dana.

Mæonia fragilis Dana (pt.), U. S. Explor. Exped. (Wilkes'), Geology, x, 1849, pp. 696–7; atlas, pl. vi, fig. 2.

Dana's original and the only description of this species is as follows: "A sharply carinate species allied to *carinata*." Glendon, valley of the Hunter.

Dana in his observations says that: "This large species is so much compressed and distorted that it cannot properly be characterized. The length is about 4½ inches and height 2½. It has an acute or sub-acute carina situated like that of the *rugulosa*. The surface is very coarsely and unevenly marked with concentric striæ or ridges, and the lines of the flattened flank make less than a right angle with those of the lateral surface. The shell appears to have been quite thin; portions remaining are much less than half a line in thickness. The lateral surface must have been a little flattened, and the lower margin, judging from the direction of the rugæ, was nearly or quite straight at middle."

Observations.—This species has not to my knowledge been discovered since Dana's specimen was collected at Glendon in the valley of the Hunter, New South Wales. Nothing new regarding it has appeared in literature, and it appears likely that as this form was described from distorted and much broken specimens, it may be synonymous with *carinata*, with which it is closely allied.

Locality.—Glendon, valley of the Hunter, Newcastle district, New South Wales.

Horizon.—Upper Marine series, Permo-Carboniferous.

EXPLANATION OF PLATES.

Plate XLVII.

Myonia elongata Dana.

Fig. 1.—Internal cast of left valve, showing nodulose surface and fringed anterior adductor muscle scar.

Fig. 2.—Cast or replica of Dana's type specimen showing general outline of valve.

Fig. 3.—Partly weathered right valve, with umbonal ridge and pallial line.

Myonia accentuata, sp. nov.

Fig. 4.—Left valve slightly tilted to show flattened postero-dorsal surface.

Fig. 5.—A typical specimen showing accentuated form of posterior extremity.

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[35] Etheridge, junr.—Rec. Austr. Mus., xii, 9, 1919, p. 190, pl. xxx, figs. 4-6.

PLATE XLVIII.

Myonia valida Dana.

Fig. 1.—Internal cast of right valve, showing heavily striated muscle scars and nodulose character of flanks.

Fig. 2.—Right valve exhibiting slight convexity in the umbonal ridge.

Fig. 3.—Cast of Dana's type specimen exhibiting outline and arched ridge.

Myonia depressa, sp. nov.

Fig. 4.—External view of left valve showing ornamentation.

Fig. 5.—Right valve showing flattened nature of the species and umbonal ridge merging with shell at inferior margin.

Myonia minor Etheridge.

Fig. 6.—Left valve of small form of *M. minor* showing strong carination.

Fig. 7.—Right valve of small form of *M. minor* exhibiting sharp carina and ornamentation.

PLATE XLIX.

Myonia carinata (Morris) Dana.

Fig. 1.—External view of right valve showing distinct ridge.

Fig. 2.—Internal cast of left valve exhibiting fringed muscle scar, heavy pallial line and nodulose structure of flank.

Fig. 3.—Cast of one of Dana's type specimens.

Myonia minor Etheridge.

Fig. 4.—Etheridge's type specimen. Note oblique angle of ridge and stumpy nature of shell.

Fig. 5.—Cast of Dana's *M. fragilis*.

Fig. 6.—Left valve of a typical specimen.

Fig. 7.—External view of right valve showing flattened compressed valve.

PLATE L.

Myonia undata (Dana).

Fig. 1.—Left valve exhibiting umbonal ridge and wide postero-dorsal slope.

Fig. 2.—Cast of Dana's specimen described as *Pholadomya* (*Platymya*) *undata*.

Myonia corrugata, sp. nov.

Fig. 3.—Left valve exhibiting heavy folded carina and raised anterior adductor muscle scar.

Fig. 4.—External view of left valve showing extreme inequilateral shell and flattened postero-dorsal surface.

THE LOWER MARINE FORMS OF *MYONIA*, WITH NOTES ON A PROPOSED NEW GENUS, *PACHYMYONIA*.

By

W. S. Dun,

Honorary Palæontologist, The Australian Museum, Sydney.

(Plates li-lii.)

As will be seen by reference to the figures on Plates li and lii, the *Myonia* of the Lower Marine of New South Wales differs markedly from the species so common in the Upper Marine. The former as a whole are characterized by smaller size and a tendency to develop thicker valves as compared with the Upper Marine types. This was due probably to the fact that the larger thin-valved types described in the first part lived in shallower and smoother waters, in some cases probably sub-estuarine. The same remarks apply equally to the members of the *Chænomya* group occurring in the Upper and Lower Marines. The affinities of *Myonia* have been discussed by Mr. H. O. Fletcher.[1]

It has been considered advisable to make a new genus, *Pachymyonia*, for Etheridge's *Mæonia morrisii*.[2]

Pachymyonia, gen. nov.

Genotype *Mæonia morrisii* Eth. fil.

The new genus is proposed for the form described by R. Etheridge, Junr., as *Mæonia morrisii*,[3] of which he says: "A very remarkable variety of *Mæonia carinata*, or a quite new form." In my opinion this form should be regarded as distinct from *Myonia* as interpreted from Dana's and allied species.

Since description, several additional specimens from Allandale and Harper's Hill have been added to the collections, some testiferous.

Pachymyonia may be regarded as a *Myonia* in which the shell is relatively short, very inflated, equivalve, umbones almost touching, ligament heavy and posterior, shell relatively thick, with well-marked concentric ridges. Well-marked cinctural depression posterior to the carina. Very prominent rounded carina, posterior scar below the termination of the hinge margin, anterior scar marginal. The hinge line is not seen in any specimen examined, but will probably show a tooth mass.

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[1] Fletcher.—Records of Austr. Museum, xix, 1932, p. .

[2] Etheridge.—Records Austr. Museum, xii, 9, 1919, p. 186, pl. xxviii, figs. 7-8.

[3] Etheridge.—*Loc. cit.*

This form differs essentially from the true *Myonia* in its more inflated form, the nature of the carina and the more massive shell.

Pachymyonia morrisii (Eth. fil.).

(Plate li, fig. 1.)

Mœonia morrisii Eth. fil., Rec. Aust. Mus., 1919, xii, pl. xxviii, figs. 7-8.

Dimensions.—

	F. 16978. (Type.)	F. 29990. (Pl. li, fig. 1.)
Length	71 mm.	76 mm.
Height	51 mm.	38 mm.
Carinal inflation	73 mm.	—

The specimen illustrated shows the thickness of the test and the ornamentation.

Locality.—Allandale, N.S.W.

Collection.—The Australian Museum, Sydney.

Pachymyonia etheridgei, sp. nov.

(Plate li, figs. 2-3; plate lii, fig. 6.)

Mœonia morrisii Eth. fil. var. ?, Rec. Aust. Mus., 1919, xii, pl. xxx, figs. 1 and 2.

This form differs from *P. morrisii* Eth. fil. in the greater length and the less accentuated depression anterior to the carina. The carina is less sinuous than in the other species. Portion of the large posterior ligament is shown in Plate li, fig. 3.

Dimensions.—

	F. 31083. (Pl. li, fig. 3.)	F. 59. (Pl. lii, fig. 6.)	F. 5734.	F. 29988.
Length	72 mm.	53 mm.*	55 mm.	72 mm.
Height	44 mm.	32 mm.	31 mm.	44 mm.
Carinal inflation	47 mm.	29 mm.	27 mm.	47 mm.

Observations.—F. 5734 is the specimen described and figured by Etheridge as *Mœonia morrisii* var. (?), which I consider should constitute a new species as hinted by him (*loc. cit.*, p. 187).

Localities.—N.S.W.: Harper's Hill (F. 31083); Farley (collected by J. Waterhouse, F. 59); railway cutting two miles beyond Lochinvar (F. 5734); Allandale (F. 29988), collected by Mr. C. F. Laseron.

Collection.—The Australian Museum, Sydney.

Myonia waterhousei, sp. nov.

(Plate lii, figs. 2-3.)

Shell very elongate, carinal ridge not acute, rounded and dying out half-way between umbo and posterior extremity. Anterior end not truncate, posterior sloping upwards slightly. Umbos twisted slightly posteriorly. Ornamented with broad growth ridges. Shell thin.

Dimensions.—

	F. 6589. (Pl. lii, fig. 3.)
Length	69 mm.
Height	38 mm.
Carinal inflation	32 mm.

* Imperfect.

Locality.—Farley, N.S.W. reg. nos. F. 6589 and F. 31084. Collected by Mr. John Waterhouse, M.A., to whom the species is dedicated.

Collection.—The Australian Museum, Sydney.

Myonia farleyensis, sp. nov.

(Plate li, figs. 5–6; plate lii, fig. 5.)

The form is close to *Pachymyonia etheridgei* so far as general contours are concerned, but differs in the absence of the marked depression exterior to the carina, the less accentuated carina, and the very evident thin-shelled condition.

The species is very abundant in the ferruginous sandstones of the Farley road cutting.

Dimensions.—

	D. 1748. (Pl. li, fig. 6.)		F. 2493.
Length	47 mm.	..	47 mm.
Height	32 mm.	..	33 mm.
Carinal inflation	29 mm.?	..	28 mm.?

Locality.—Farley (road cutting), N.S.W. D. 1748 collected by Prof. Sir T. W. E. David, F. 2493 collected by Mr. J. Waterhouse.

Collection.—Both specimens in Mining and Geological Museum.

Myonia davidis, sp. nov.

(Plate li, fig. 4; plate lii, fig. 4.)

Shell subquadrate, carina well marked, acute, posterior margin sloping upwards. Anterior rounded, slight depression anterior to carina.

Dimensions.—

	F. 2486.		F. 30060. (Pl. lii, fig. 4.)
Length	70 mm.	..	61 mm (?)
Height	44 mm.	..	41 mm.
Carinal inflation	31 mm.	..	32 mm.

Locality.—Ravensfield, N.S.W. F. 2486, collected by Prof. Sir T. W. E. David; F. 30060, collected by Mr. C. F. Laseron.

Collection.—The Australian Museum (F. 30060) and the Mining and Geological Museum (F. 2486).

Myonia parallela, sp. nov.

(Plate lii, fig. 1.)

Shell elongate, anterior margin rounded, subacute, posterior truncate. Carina well marked, straight, not very acute. General contour sub-parallel. Lower margin only slightly curved.

Dimensions.—

	F. 2473.
Length	65 mm.
Height	28 mm.
Carinal inflation	10 mm. (?)

Locality.—Harper's Hill, N.S.W. Collected by Prof. Sir T. W. E. David.

Collection.—The Mining and Geological Museum.

EXPLANATION OF PLATES.

Plate LI.

Fig. 1.—*Pachymyonia morrisii* Eth. fil. Partly testiferous specimen. Australian Museum reg. no. F.29990. Allandale, N.S.W.

Fig. 2.—*P. etheridgei*, sp. nov. Australian Museum, reg. no. F. 31083. Locality: Harper's Hill, N.S.W.

Fig. 3.—The same, showing portion of ligament.

Fig. 4.—*Myonia davidis*, sp. nov. Mining and Geological Museum, reg. no. F. 2486. Ravensfield, N.S.W.

Fig. 5.—*Myonia farleyensis*, sp. nov. Mining and Geological Museum, reg. no. F. 2493. Farley, N.S.W .

Fig. 6.—*Myonia farleyensis*, sp. nov. Mines Department, reg. no. D. 1478. Farley, N.S.W.

Plate LII.

Fig. 1.—*Myonia parallela*, sp. nov. Mining and Geological Museum, reg. no. F. 2473. Harper's Hill, N.S.W.

Fig. 2.—*M. waterhousei*, sp. nov. Harper's Hill, N.S.W.

Fig. 3.—*M. waterhousei*, sp. nov. Australian Museum, reg. no. F. 6589. Farley, N.S.W. Showing more accenuated carina.

Fig. 4.—*M. davidis*, sp. nov. Australian Museum, reg. no. F. 30060. Ravensfield, N.S.W.

Fig. 5.—*M. farleyensis*, sp. nov. Farley, N.S.W.

Fig. 6.—*Pachymyonia etheridgei*, sp. nov. Australian Museum, reg. no. F. 59. Farley, N.S.W.

GEOLOGICAL AND MINERALOGICAL OBSERVATIONS IN CENTRAL AUSTRALIA.

By

T. Hodge-Smith,

Mineralogist, The Australian Museum.

(Plates liii-lv; Figures 1-12.)

Introduction.

By the invitation of the Mica Corporation of Australia Limited, and the generous assistance of a number of donors, I was enabled to accompany Messrs. J. Dale and R. Barlow on an expedition to Central Australia. Our method of transport was by motor lorry, and altogether we travelled 850 miles in Central Australia. Entering the Territory from Queensland at about latitude 21° 51′ south, we travelled 25 miles south along the Queensland-Central Australia border fence to Tobermory Station, and then in a general west-by-south direction for 204 miles to Oorabbra Water Holes. From here we changed direction to approximately south-west. Crossing the Marshall and Plenty Rivers, and passing over the Hart Range, through Arltunga, we reached Alice Springs in the MacDonnell Range, a further distance of 180 miles. Returning to the Hart Range, we established a camp and remained in these ranges for a period of four weeks. It will be obvious that any work carried out is purely in the nature of reconnaissance, and all that can be hoped for is that these notes may add a little to our knowledge of this very remote and exceedingly interesting area. I am greatly indebted to Assistant Professor W. R. Browne for much valuable help in their preparation and for petrological determinations, and to Mr. R. O. Chalmers for the chemical analyses carried out by him.

The period of my sojourn in Central Australia was from the 12th October, 1929, to the 1st December, 1929. The maximum shade temperature recorded was 104° F. at 4 p.m. for several days, while the minimum temperature was 71·6° F. on the night of the 4th November. During the month of October it rained for six consecutive days, which, I understand, is a very rare happening for that time of the year. A week prior to our leaving the Territory, heavy rain set in, which was largely responsible for our returning somewhat earlier than we had intended. Once the wet season sets in, travelling is almost impossible.

The average yearly rainfall for the Hart Range area is under ten inches, and the country presents a very arid appearance. The vegetation is distinctly desert in type, except along the river courses, where the eucalypts are represented by several species, especially the Bloodwood (*E. terminalis*) and the Red Gum (*E. rostrata*). Elsewhere the acacias, particularly the mulga and gidyea, predominate. A coarse wiry grass covers many of the flat sandy valleys.

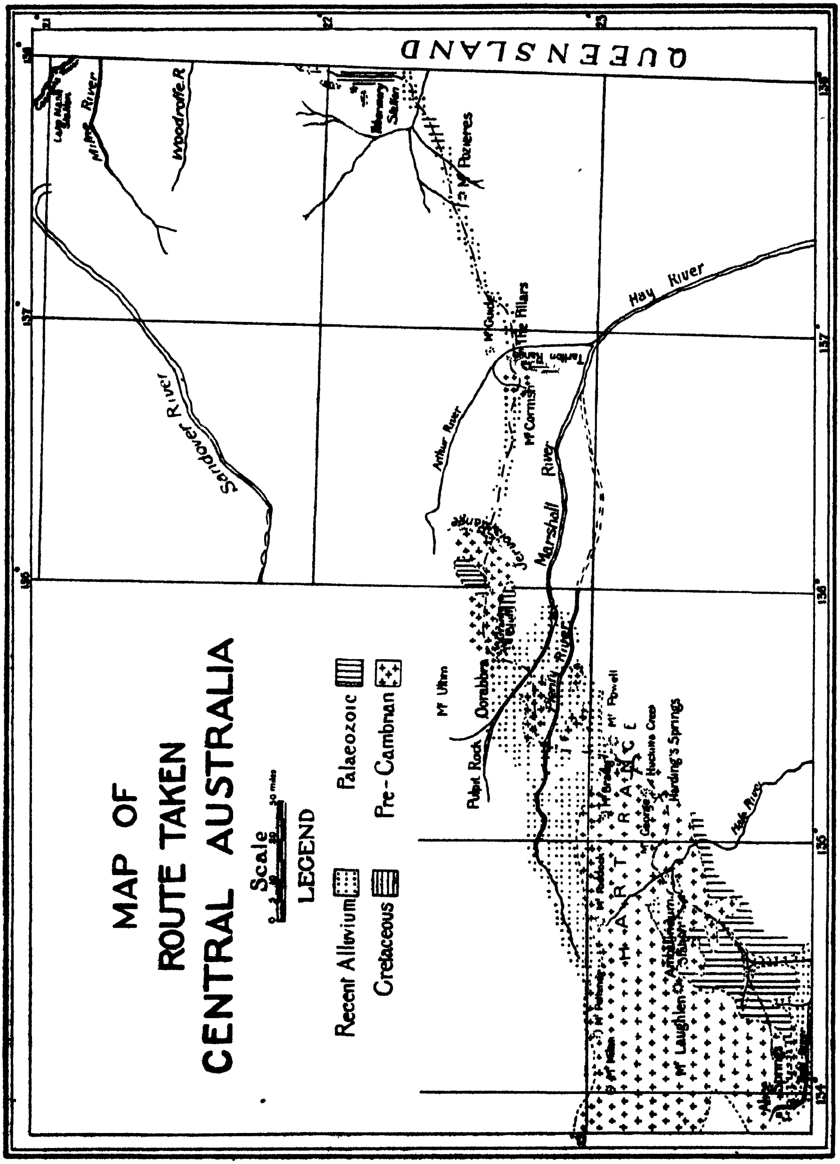
MAP OF
ROUTE TAKEN
CENTRAL AUSTRALIA
Scale
LEGEND
Recent Alluvium
Cretaceous
Palaeozoic
Pre-Cambrian
QUEENSLAND
Sandover River
Woodroffe R.
Hay River
Marshall River
Arthur River
The Pillars
Mt Cornish
Plenty River
Mt Ultim
Oorabbra
Albert Rock
Mt Powell
Harding's Springs
Mt Laughlen
Alice Springs

Figure 1.

Previous Work.

Several expeditions and exploring parties have traversed various parts of Central Australia, and a number of reports have been published. Only those papers that deal either directly or indirectly with the area under discussion are referred to. I have been unable to find anything dealing with the geology of that area which lies between the Queensland border and Jervois Range.

The first important contribution to the geology of Central Australia is the report of the geologists of the Horn Expedition.[1] They recognized the pre-Cambrian as consisting of metamorphosed sediments, rocks of doubtful origin, including a great part of the gneisses, and eruptive rocks. To the mica-bearing dykes they gave the name of "Oolgarna" granite. Other eruptive rocks of this complex include diorite, gabbro, dolerite, olivine dolerite, epidote rocks, and amphibolite. The absence of Cambrian rocks was noted, and the Ordovician strata were stated to lie unconformably directly on the pre-Cambrian.

In 1896 Mr. H. Y. L. Brown[2] visited the Arltunga Goldfield and the Hart Range Mica-fields, and travelled north across the Plenty and Marshall Rivers to Oorabbra, thus covering a good deal of the area described in these notes. He classifies the pre-Cambrian as Archæan. The limestones and quartzites at Heavitree Gap, as well as those of the Ooramina Range, are designated Cambrian. He recognizes a second series of Palæozoic rocks on the Finke River as Lower Silurian. He describes the auriferous diggings and reefs of Arltunga and the mica claims of the Hart Range.

In 1914 Dr. C. Chewings[3] wrote on the stratigraphy of Central Australia, giving the age of the quartzites and limestones near Arltunga as Cambrian, as he had discovered *Cryptozoon* in the limestone.

In the same year Mr. R. Lockhart Jack[4] visited the Musgrave and Everard Ranges. He describes the pre-Cambrian sediments and oldest plutonic rocks as being both intruded by a very great development of granite, designated the Everard Range type. He regards the pegmatites as being injected during the consolidation of the granite magma, and states that many of them are exceedingly quartzose. The latest members of the pre-Cambrian complex consist of an extensive series of basic dykes. He also recognizes two younger formations, the Cambrian and the Ordovician.

In 1925 Dr. L. K. Ward[5] agreed with the opinion of the geologists of the Horn Expedition regarding the absence of the Cambrian, pointing out that "the *Cryptozoon* specimens occur on the same stratigraphical horizon as *Orthis leviensis*". In regard to the pre-Cambrian complex he states: "Quartz veins, some containing tourmaline, traverse the gneisses at many places, and are probably related genetically to the pegmatites. Less common are the intrusive amphibolites. The youngest and least altered members of the pre-Cambrian group at Alice Springs are the intrusive dykes of gabbroid character."

[1] Tate and Watt.—Report of the Horn Expedition, iii, Geology and Botany, 1896.
[2] Brown, H. Y. L.—Reports on Arltunga Goldfield, etc., South Australia, 1897.
[3] Chewings, C.—Trans. Roy. Soc. S. Austr., xxxviii, 1914, pp. 41-52.
[4] Jack, R. Lockhart.—Geol. Surv. S. Austr., Bull. 5, 1915.
[5] Ward, L. K.—Trans. Roy. Soc. S. Austr., xlix, 1925, pp. 61-84.

In 1928 Dr. C. Chewings[6] again wrote on the stratigraphy of Central Australia, referring to the auriferous White Range quartzites and the Heavitree Gap quartzite as being of the same age, probably Cambrian. He regards them as down-faulted remnants of sediments that originally overlay the pre-Cambrian.

Sir Douglas Mawson and Mr. C. T. Madigan[7] have given the name Arunta Complex to the older pre-Cambrian rocks, and the strata resting unconformably on this complex they regard as post-Aruntan and pre-Ordovician, dividing them into two series, the Pataknurra Series and the Pataoorrta Series. They prove that these rocks are stratigraphically below the Ordovician beds of the Horn Valley.

Geology.

It will be seen from an examination of the section, purely diagrammatic, along the route taken (Figure 3) that there are two geographically and geologically distinct areas, and it is proposed to describe these two areas separately. The first area comprises the country between the Queensland border and Jervois Range, and the second extends from Jervois Range to Arltunga in the White Range.

The Area Between the Queensland Border and Jervois Range.

This area is mostly flat, with an elevation of 400 to 600 feet above sea-level (aneroid readings). Relief is afforded by a number of flat-topped hills and ridges rising not more than fifty feet above the level of the surrounding country, and the Tarlton Range, with a north-by-west and south-by-east trend, standing approximately 200 feet above the level of the plain. The greater part of our route passed over plains consisting of loose sandy loam of a red colour, which presented great difficulties to the motorist, proving in wet weather an almost insuperable barrier. The sandy loam very effectively covers all outcrops, except at a place nine miles north of Tobermory Station, where limestone, dolomite, quartzites and sandstones are seen striking from north-east and south-west to east-north-east and west-south-west, with a dip of 20° westerly.

The flat-topped hills and ridges are composed of limestones, marls, sandstones, and conglomerates. They are nearly always capped with porcellanite, which does not show any well-marked junction with the underlying limestone, and varies in thickness from a few inches to as much as eight feet. It is a hard compact material, white to pale grey in colour, forming a very jagged surface, and is the typical duricrust of Dr. W. G. Woolnough.[8] There is definite evidence of the porcellanite replacing the limestone and marls on which it rests, and there can be little doubt that the siliceous solutions responsible for deposition and replacement of the limestone have come from below the latter.

The beds forming the flat-topped hills and ridges are horizontal or almost so, a few dips obtained measuring 2° south-west approximately. The limestone is somewhat arenaceous, merging into marls and calcareous sandstones. It is usually fine-grained, and of a light buff colour. A few miles east of Mount Guide a very coarse conglomerate was seen immediately underlying the limestone. It consists

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[6] Chewings, C.—Trans. Roy. Soc. S. Austr., lii, 1928, pp. 62-84.
[7] Mawson, D., and Madigan, C. T.—Quart. Journ. Geol. Soc., lxxxvi, 1930, pp. 415-429.
[8] Woolnough, W. G.—Geol. Mag., lxvii, 1930, pp. 123-132.

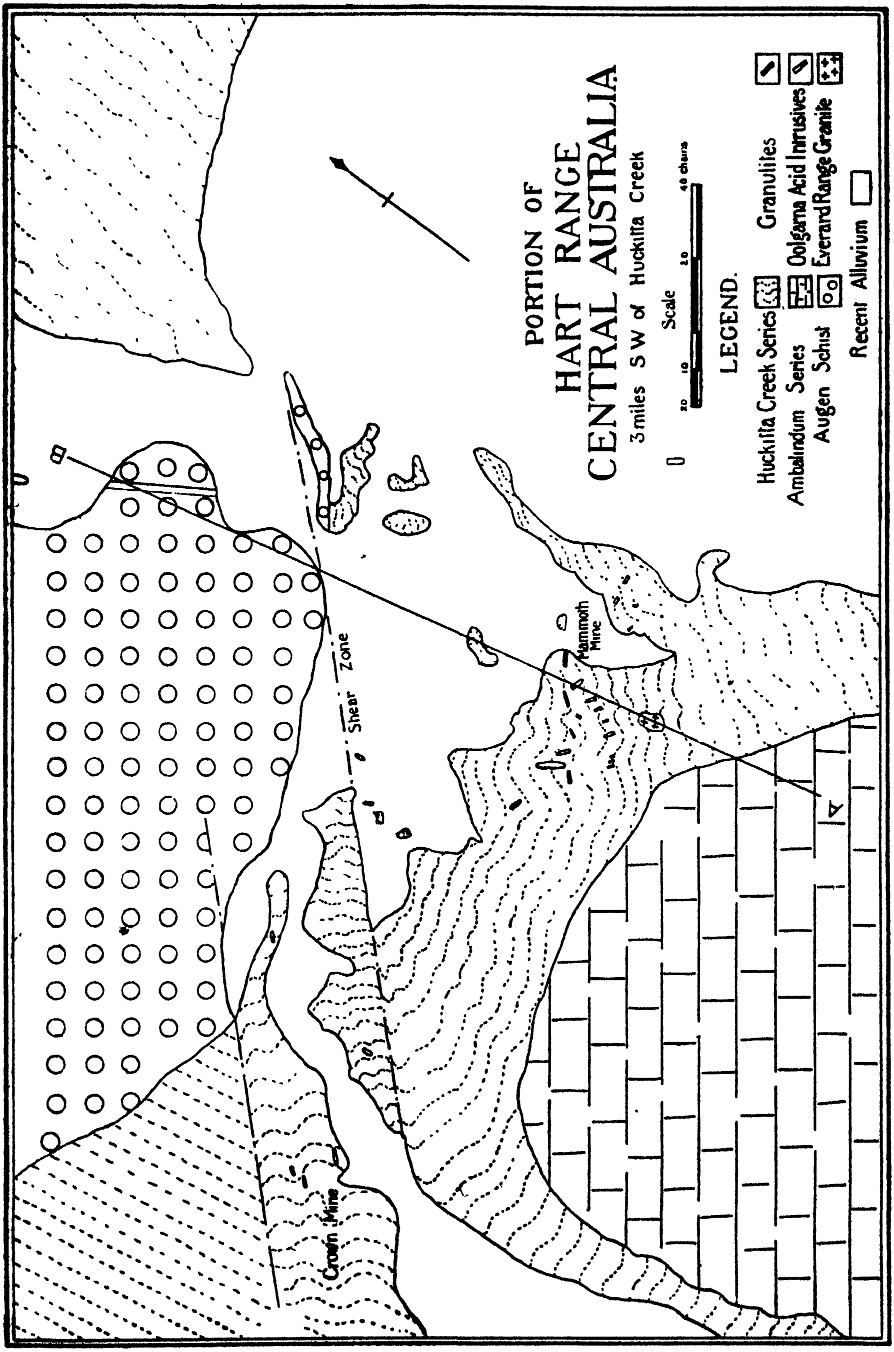
PORTION OF
HART RANGE
CENTRAL AUSTRALIA
3 miles S W of Huckitta Creek
Scale
40 chains
LEGEND.
Huckitta Creek Series
Ambalindum Series
Augen Schist
Recent Alluvium
Granulites
Oolgarna Acid Intrusives
Everard Range Granite
Mammoth Mine
Shear Zone
Crown Mine

Figure 2.

of boulders of white quartz, measuring up to as much as eighteen inches in diameter, set in a matrix of very ferruginous sandstone.

Although very many of these hills and ridges were examined, no traces of fossils were found, so that it is impossible to assign any age to the rocks. Lithologically they bear a distinct resemblance to the Rolling Downs formation of Central Queensland. They appear to lie unconformably on the tilted beds near Tobermory Station, and may possibly be of Cretaceous age. There is no evidence whatever as to the age of the tilted beds. So far as I am aware, there has

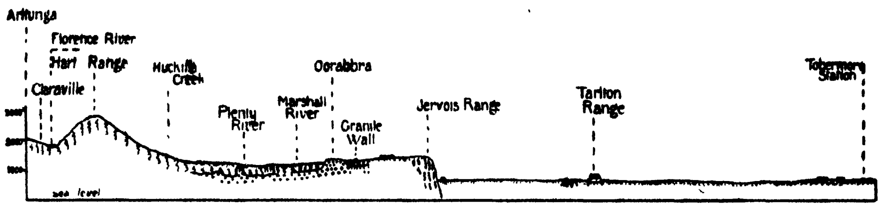

Fig. 3 Diagrammatic Section along the line of Route from Tobermory to Arltunga to Central Australia

Legend

Pre-Cambrian { Schists & Gneisses; Everard Range Granite
Palaeozoic
Cretaceous?
Recent Alluvium

been no work carried out in this area. At the beginning of 1895, Mr. H. Y. L. Brown[*] travelled from Powell's Creek to Alexandria and back. This area is approximately one hundred and fifty miles due north of the area under review, and appears to be the same flat type of country. Brown mentions the presence of basaltic rocks overlying the sandstone a short distance north of Renner's Springs, and the presence of agate in the soil, probably derived from this basalt. In the area traversed by me there was no sign of basaltic rocks or agate. The country described by Brown is of greater elevation than the country under review, being "from 900 to 1,000 feet above sea level (barometer)". He groups the rocks of that area in the following series:

(1) Recent and Tertiary deposits.
(2) Quartzites, sandstones, grits, conglomerates, and shales.
(3) Limestone, shale, marl, calcareous sandstones, etc.
(4) Quartzite, sandstone, slate, etc., of Lower Palæozoic age.

The basaltic rocks overlie the sandstones of the second group, and it would appear that this series is entirely absent from the area under review. I suggest that the flat-topped hills and ridges represent residuals of Brown's third series, while the tilted limestones, quartzites, sandstones, etc., seen near the Queensland border represent his fourth series, which he considers of Lower Palæozoic age. There is a possibility that these rocks may be even older; further work may show that they are Nullagine in age.

The Tarlton Range is 134 miles west of the Queensland border, and although we passed through a narrow gap in this range, circumstances did not permit

[*] Brown, H. Y. L.—Report on Northern Territory Explorations, Adelaide, 1895, pp. 22-27.

of us making any examination. In passing through we had a particularly trying time, taking five days to travel eighty miles, and it was decided to leave any examination until our return. Unfortunately, on our return a very heavy thunder-storm overtook us, and the whole country was more or less covered with a sheet of water, so that it was necessary to travel at full speed through this in order to reach safety before the water soaked in and made travelling impossible. The range is quite narrow and flat-topped, rising steeply from the plain to a height of about 200 feet (by inspection only). It trends approximately north-by-west to south-by-east, and is composed of horizontal rocks which have the appearance of being somewhat old, probably Palæozoic. We passed through the northern end of the range, and here denudation has proceeded to such an extent as to form a number of mesas, such as Mt. Guide and Goyder's Pillars.

Some eleven miles to the west of this range, in the vicinity of a tributary of the Arthur River, an outcrop of a coarse pink granite with gneiss and bands of hæmatite schist was passed over. The felspar of the granite is microcline, and both muscovite and biotite are present. There can be little doubt that this is an inlier of pre-Cambrian rocks.

There is, in my opinion, little possibility of finding artesian water in this country by boring. Although most of the rocks are concealed by the covering of sandy loam, the presence of crystalline rocks of probably lower Palæozoic age, or even older, in the eastern part of the area, and of undoubted pre-Cambrian rocks in the western section, precludes the possibility of the presence of any porous strata capable of carrying artesian water.

At the little mining settlement at Jervois Range a very prominent outcrop of pre-Cambrian schists and gneisses is seen. They have a general north-and-south trend just here, but a few miles further south they turn to the south-west. The outcrop rises about 100 to 200 feet above the level of the plain, and owes its prominence to the fact that the schists and gneisses have been injected by great masses of white quartz, and also possibly to the fact that they have been injected by mineralizing solutions carrying the sulphides of copper and lead. The ore-bodies consist of a number of relatively small lenses arranged more or less *en echelon* with their longer axes lying in the general direction of the outcrop, that is, approximately north-and-south. The schists and gneisses are very much folded and twisted.

At the time of our visit, mining operations had commenced, and three shafts were in the process of making, but the greatest depth reached was only eighty-three feet at the shaft known as Hanlon's Reward. In this shaft, sunk on the outcrop of one of the lenses of ore, galena was passed through to forty feet, but from here to the bottom of the shaft was muscovite-sericite schist impregnated with chalocpyrite. One notable feature of the lode, or rather lodes, was the scarcity of oxidized minerals. Unaltered galena was seen right on the surface outcrop, although the copper minerals appeared to have suffered a greater amount of alteration.

The primary minerals are represented by chalcopyrite, galena, pyrite (cobalti-ferous), also magnetite in the form of a dyke cutting the lodes. The secondary minerals consist of cerussite, pyromorphite, chalcocite, covellite, malachite, azurite, sphaerocobaltite, limonite, and manganese oxide. The non-metallic minerals include

quartz, felspar, mica, sericite, fluorite, and garnet. These minerals will be described under the heading of mineralogy.

The outcrop lies less than half a mile to the east of the Jervois Range scarp, and runs parallel to it. This scarp rises very steeply to a height of 800 feet above the plain. It has suffered very little dissection, and we were able to climb on to the tableland only by a very narrow steep gorge a few miles to the south of the mining settlement. I think there can be little doubt that it is a typical fault-scarp separating the pre-Cambrian shield of Central Australia from the plains to the east. It reminded me of the Mundi Mundi fault-scarp, which marks the western limit of the Broken Hill pre-Cambrian shield and separates it from the plains to the west.

THE AREA BETWEEN JERVOIS RANGE AND ARLTUNGA.

The whole area consists of a plateau ranging from 1,400 to 2,000 feet above sea-level. Leaving the Plenty River and travelling in a general south-west direction, we crossed three ranges, the Hart Range, the White Range, and the MacDonnell Range, although the latter is outside the area under review. The highest peak in these ranges is Mt. Heughlin, 4,756 feet above sea-level, situated in the MacDonnell Range. A few peaks were found to be over 3,000 feet above sea-level.

The rocks of this area have been divided into four distinct series, as follows:

(*a*) Recent alluvium and secondary limestone.
(*b*) Early Palæozoic quartzites, sandstones, limestones, etc.
(*c*) Pre-Ordovician and post-Aruntan Series.
(*d*) The pre-Cambrian (Arunta) complex.

(*a*) THE RECENT ALLUVIUM AND SECONDARY LIMESTONE.

Between the Jervois Range and the Hart Range a great deal of the country is covered by recent alluvium consisting of a red to buff-coloured sand. In the mountainous country these sands are confined to the valleys and are often characterized by an abundance of garnet crystals and fragments. Some of the creek beds are composed of a white sand, with here and there patches of garnet sand of a peculiar red colour. This is particularly noticeable in the Florence River.

A peculiarity of many of the valleys in these ranges is the wide flat base of alluvium bounded on either side by steep rocky ridges. The monotony of the flat base is relieved here and there by small inliers of rock forming very low hills. All the creek beds are broad and shallow, and are seen meandering along these valleys in exactly the same manner as a mature river. The only evidence obtained as to the depth of the alluvium was at a spot some twenty-five miles south-west of Claraville on the road to Alice Springs, where a well was in the course of construction and had not reached rock bottom or water at fifty-five feet. This structure points to a very much increased rainfall in former times, when the streams were capable of carving out deep valleys. With the present day low rainfall the streams are incompetent to carry away the alluvium so that there has been a gradual silting up of the valleys.

At the eastern extremity of the Hart Range dissected alluvial fans were seen very similar to those described by Mr. E. C. Andrews,[10] formerly Government

[10] Andrews, E. C.—Geol. Surv. N.S.W., Mem., Geology No. 8, 1922, p. 25.

Geologist, and a Trustee of this Museum, at Broken Hill. In a small gully some four miles south of Huckitta Creek a deposit of travertine was seen forming fan-like masses along the sides of the gulley. It was obviously derived from a bed of altered limestone found near the top of the hills on either side of the gully. A deposit of secondary limestone occurred forty-five feet below the surface at the well previously referred to.

(*b*) EARLY PALÆOZOIC QUARTZITES, ETC.

To the north of the Marshall River a number of flat-topped mesas form a conspicuous part of the landscape. Unfortunately, I was unable to get more than a distant view of these hills except in one case in the vicinity of Oorabbra, when I was only able to make a hasty inspection. I can only say that here they consist of quartzite, sandstone and possibly limestone, and that they are horizontally bedded, resting unconformably on the Arunta Complex. No fossils were obtained, but from their lithological characters the rocks appear to be much older than those found east of Jervois Range, with the possible exception of the Tarlton Range. It is quite impossible to say what is their relation to the pre-Ordovician and post-Aruntan series further to the south. In spite of the fact that they both rest directly on the Arunta Complex, I am inclined to the opinion that the rocks of the mesas to the north of the Marshall River are somewhat younger than those exposed in the Arltunga district, but a good deal of work would be required to determine this relationship.

It is of interest to note that Mr. H. Y. L. Brown divides these beds into two series. One small outcrop marked in by him in his map, to the south of the Plenty River, is incorrect. This particular outcrop certainly belongs to the Arunta Complex, and has produced quantities of mica.

(*c*) THE POST-ARUNTAN AND PRE-ORDOVICIAN SERIES.

Sir Douglas Mawson and Mr. Madigan[11] have proved very conclusively that the Heavitree quartzite belongs to this series and not to the Ordovician as suggested by Dr. Ward.[12] It is the basal bed of the series and lies unconformably on the Arunta Complex with a steep dip southwards. These beds are also met with in the White Range, where they are again seen dipping steeply to the southward. As excellent descriptions of these rocks have been given by the writers previously referred to, and as nothing new can be added, it would be useless to repeat such descriptions here.

(*d*) THE PRE-CAMBRIAN (ARUNTA) COMPLEX.

This great complex consists of intensely metamorphosed rocks of igneous, sedimentary, and doubtful origin. It is proposed to make a tentative classification of the complex as follows:

i. The Huckitta Creek Series consisting of schists and gneisses of both sedimentary and igneous origin.

ii. The Ambalindum Series consisting of altered limestone and schist.

[11] *Loc. cit.*
[12] *Loc. cit.*

iii. The Everard Range Granite.
iv. Oolgarna Acid Intrusives (Oolgarna Granite).
v. The Augen Schist.

i. *The Huckitta Creek Series.*—All the rocks of this series have been subjected to both thermal and dynamic metamorphism. In some localities they have been intensely folded, particularly where they are associated with the Augen Schist.

Fig 4 Section along A.B. in Fig 2.

Recent Alluvium
Ambalindum Series { Quartzite, Quartz schist, Altered Limestone
Huckitta Creek Series
Everard Range Granite
Oolgarna Acid Intrusives
Augen Schist

In other localities they show remarkably little evidence of any folding. A number of measurements taken over a distance of about sixty miles from Oorabbra to Harding Springs at localities where the schists and gneisses have suffered least contortion, show a variation of strike from north 7° west to north 5° west, while the dip varies from 20° to 35° easterly.

To the west of the Crown Mica Mine is an area of schists and gneisses with little or no contortion which dip at a remarkably low angle. An unsuccessful effort was made to determine the relation of the bedding-plane to the plane of schistosity. The schists very easily split along the plane of schistosity, and it is probable that this plane is parallel to the bedding-plane.

A small area some thirteen square miles in extent to the south-west of Huckitta Creek Road Crossing was selected for mapping as showing the main features of the Arunta Complex. Reference to this map (Fig. 2) will show in the vicinity of the Mammoth Mica Mine an area of the Huckitta Creek Series which is intensely folded and intruded to the north by the Augen Schist. A well marked shear zone passes through this area with a north-east strike and appears to have involved the Augen Schist as well as the Huckitta Creek Series. There is evidence of one or perhaps two minor faults striking parallel with the main shear zone. This fault can be clearly seen in the Augen Schist, where it has a vertical throw of not less than 500 feet, and an almost vertical dip. As the junction line between the unfolded and folded schists is continuous with the strike of the fault in the Augen Schist, it seems fairly certain that this fault is continued into the Huckitta Creek Series.

In the field the most striking feature of the rocks of the Huckitta Creek Series is the almost universal development of felspar. Many of the schists and gneisses show augen structure, and in every case examined the "eyes" proved to consist of felspar. Many of the rocks are highly garnetiferous, although crystals of garnet seldom exceed an inch in diameter and are often very much smaller.

No systematic attempt has been made to determine the original character of the schists and gneisses, as much field work and many chemical analyses besides petrological examinations would be required. The disconcerting way in which a typical gneiss will gradually change along its strike to a typical mica schist, would render any conclusions reached after a visit such as this one was purely a matter of guesswork.

While many of the rocks undoubtedly consist of mixed rocks, and many are of doubtful origin, there are a few types which permit of classification.

Rocks of sedimentary origin consist of biotite-schists, biotite-sillimanite-schists, sillimanite-gneisses, and altered limestones.

The biotite-schists are mostly garnetiferous, though a few coarse types appear to be devoid of garnet. The garnets vary considerably in size and also in quantity, but these two characters do not appear to bear any relation to each other. One of the biotite-schists in the vicinity of the Mammoth Mica Mine contains stretched quartz pebbles measuring up to a foot or more in length, with a maximum diameter of only about two inches, and represents a metamorphosed conglomerate.

The biotite-sillimanite-schists are invariably garnetiferous, and they vary from fine to medium-grained rocks. The garnets generally occur plentifully in small to medium-sized crystals. The colour of the rock varies from dark to pale grey. A little muscovite is sometimes present in these rocks.

The sillimanite-gneisses are pale grey rocks which are sometimes rather friable, and, like the other rocks, they often contain garnet.

The altered limestone consists of a compact very pale grey rock showing slight schistose structure. It is composed of calcite, diopside, scapolite, sphene, quartz, and a little biotite. It is best seen at Huckitta Creek, but is also found about three-quarters of a mile west of the Mammoth Mica Mine.

The igneous rocks of this series are of two types, acid and basic. The acid type consists of gneisses and aplite which are intercalated with the schists and follow the contortions of those rocks. They are sill-like masses varying in width from a few inches to a few feet in thickness. Many of these sills taper off along the direction of their strike, and thus resemble the lenses of granite gneiss seen at Huckitta Creek. There can be little doubt that some of the gneisses are genetically related to the Everard Range Granite, though some, particularly the garnetiferous gneisses, appear to belong to a much older intrusion. It is possible that some of the acid rocks of igneous origin included in the Huckitta Creek Series should rightly belong to the Acid Intrusives, but they are placed here tentatively because of their occurrence.

Of the gneisses which differ from the normal granite gneiss, which is sometimes garnetiferous, the following may be mentioned.

The aplitic gneisses are very fine-grained rocks of pale pink colour with occasional phenocrysts of felspar. The banding in these rocks is often on a very fine scale.

A quartz-biotite gneiss consists of fairly coarse bands of quartz with a little biotite and biotite with very little quartz.

The quartz-mica-diorite gneiss is always a dark coloured rock with fine banding and much biotite. This rock is not so acidic as the other rocks.

The granite that occurs in these sill-like masses is really indistinguishable from the Oolgarna granite. It is coarse-grained, and may be either pink or grey in colour according to the colour of the felspar, which is mostly microcline.

There are three different modes of occurrence of the rocks of igneous origin of basic type. They occur as sill-like masses similar to those of the acid types, as dykes cutting across the schists and gneisses, and in one case as a boss-like mass.

The sill-like masses consist of amphibolites and hornblende schists, which are sometimes garnetiferous. In addition there is a very striking gneiss consisting of narrow bands of the black hornblende alternating with reddish bands of felspar. In the hand specimen the amphibolites and hornblende schist are fairly compact rocks, varying in colour from greenish-black to grey. They are typically schistose in structure and occasionally contain phenocrysts of felspar.

The dykes of metamorphosed basic igneous rock cut across the schists and gneisses, and vary in width from a few inches to about two feet, and in length from about a foot to as much as half a mile. It is remarkable the number of times these basic dykes were found in close proximity to the dykes of the Acid Intrusives, and yet in no case were they seen in actual contact. Another peculiar feature was that the dykes of the two series were more often than not at right angles to each other.

These rocks are very compact and tough, with a more or less bluish-black colour. In the hand specimen they sometimes have the appearance of ordinary fresh basalt, though more frequently they have a somewhat felted appearance. Phenocrysts of felspar are often present in these rocks.

From the field evidence alone these rocks would not be placed in the Huckitta Creek Series. They would be considered much younger than this series. Where they occur in areas of contorted schists and gneisses the dykes have been unaffected by the folding. Petrological evidence, however, clearly shows that these basic dyke rocks have been subjected to high-grade thermal metamorphism comparable to that which produced the sillimanite schists and have thoroughly recrystallized to granulites; for this reason they must be considered ancient and therefore have been placed in this series.

The boss-like mass of metamorphosed basic igneous rock covers many acres, forming a prominent peak rising to 2,730 feet above sea-level (barometer), about one mile west of the Crown Mica Mine.

ii. *The Ambalindum Series.*—The name proposed for this series is the name of the station property on which they occur. The series is represented by an isolated block of rocks to the south of the Mammoth Mine, covering an area of approximately six square miles, and has a thickness of at least 500 feet, probably more, and dips gently to the south-west. The basal bed of altered limestone rests with marked discordance on the rocks of the Huckitta Creek Series. It was not possible to determine whether this was really an unconformity or whether the series owes its present position to overthrust faulting. Figure 4 shows the relation of these rocks to those of the other series.

The topmost bed consists of quartzite, often rich in garnet, and, like the remainder of the series, is intruded by very acid rocks which probably belong to the Acid Intrusives. There are two beds of limestone separated by a band of

schist. The limestone has been entirely recrystallized, and in a number of places saccharoidal structure is well developed. Often it is rich in diopside, scapolite, grossularite, sphene, and quartz. The schist between the two beds of altered limestone is in the main a quartz schist. It appears to have suffered more contortion than the limestone. It contains a band of quartz-garnet-magnetite rock which follows the contortions of the schist. This band is about eight inches wide, and because of its dark colour stands out prominently in the quartz schist. A similar rock to this has been described by Professor W. R. Browne[13] from Broken Hill, New South Wales. He places it tentatively among the older basic igneous rocks of the Willyama Series.

One of the quartz veins in the quartz schist was found to contain a very small amount of chalcopyrite, with the consequent green copper staining. A small shaft had been sunk on this, but had been abandoned. It is of interest to note that the auriferous reefs of the White Range also carry copper minerals.

iii. *The Everard Range Granite.*—This granite forms a great bathylith, and outcrops in numerous places over a very wide area some thousands of square miles in extent. It was given the name of Everard Range Granite by R. Lockhart Jack[14] in his description of the Musgrave and Everard Ranges in 1915. The best outcrop and the most extensive one examined is situated at Oorabbra, some forty miles west of the Jervois Range Mining Settlement. It is a gneissic granite, but the gneissic structure varies considerably. In areas where the Huckitta Creek Series has been subjected to more intense metamorphism the granite more nearly approaches a typical gneiss, and in some very disturbed areas it is quite possible that outcrops of this rock were not recognized for this reason.

At the road crossing at Huckitta Creek the gneissic granite is definitely intrusive into the Huckitta Creek Series, and typical *lit-par-lit* injections (Plate liv, fig. 4) are to be seen here, the granite occurring as lenses in the schists along well defined zones.

The granite is generally coarsely crystalline, and is sometimes porphyritic, the phenocrysts being microcline. Muscovite is always present and only rarely biotite. Quartz is found in less quantity than the felspar.

iv. *The Oolgarna Acid Intrusives.*—These have been divided into two series mainly because of their different appearance in the field. As a matter of fact, it seems fairly certain that both series represent the same phase of igneous activity, and their appearance and mineral constitution are due largely to the nature of the rocks they have intruded. They have been called pegmatites, while the geologists of the Horn Expedition designated the mica-bearing dykes as the Oolgarna Granite. In addition to both pegmatite and granite dykes there are quartz dykes and dykes which include more than one type of rock, and for this reason it is thought advisable to extend the term Oolgarna Granite to Oolgarna Acid Intrusives, which is more comprehensive in its application.

(*a*) *The Granite Dykes.*—Some of these dykes are of enormous size with very prominent outcrops. One dyke (Plate liii, fig. 5), which can be traced for nine miles in a straight line, is about twenty feet wide and rises sixty feet above

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[13] Browne.—Geol. Surv. N.S.W., Mem., Geol. No. 8, 1922, Appendix I, p. 338.

[14] *Loc. cit.*

the level of the surrounding plateau. In other cases they are less than a foot in width, and persist only for a chain or so in length. They are found intruding all the rocks of the Arunta Complex.

The granite is always coarse-grained and sometimes extremely so. Usually it is pink in colour, but may also be light grey, the colour being controlled by the felspar present, which is microcline. Both muscovite and biotite are present, though generally either one or the other predominates.

(*b*) *The Quartz and Pegmatite Dykes.*—These dykes vary in size from an inch or so to more than two chains in width, and from a few inches to as much as quarter of a mile in length. They can be numbered by the thousand.

Like the granite dykes, they consist principally of quartz and felspar, mostly microcline, with such minerals as mica, tourmaline, beryl, apatite, garnet, and diopside. Some of these accessory minerals seem to be controlled to a large extent by the nature of the rock intruded. For instance, where the dykes cut typical mica-schists they invariably contain large crystals of mica, often of considerable commercial value, and it is only under such conditions that payable mica is found. Diopside has been found only where they intrude altered limestones.

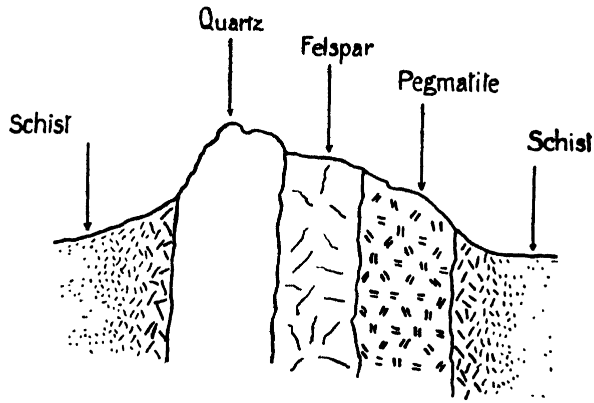

Fig. 5.—Diagrammatic section through a typical dyke of the Oolgarna Acid Intrusives, Hart Range, Central Australia.

A typical section of one of these dykes (Fig. 5) was seen at Lindsay's Mica Mine, eight miles south-by-west of Harding Springs. The dyke is divisible into three distinct vertical zones separated by fairly sharp walls. On the hanging wall side coarse pegmatite is found carrying a fair quantity of mica, the central zone is composed of massive felspar, while the footwall side of the dyke consists of massive white quartz. The two latter zones carry only a minor amount of mica, but at their contact some of the largest books of mica have been found. Elsewhere dykes occur which do not show this vertical zoning, but they always consist of one or other of the zones. Sometimes only two of the zones are represented.

Although the junction with the country rock is always well defined, the dykes have had a profound effect on that rock in many places. This is best seen where they had intruded mica-schists. Almost invariably the mica of the schist has been recrystallized adjacent to the walls of the dyke. In one case the miner had not bothered to work the mica-bearing dykes, but had contented himself with working the recrystallized mica of the schist. There is no sharp line of demarcation between the recrystallized mica and the unaltered schist, but merely a gradual diminution in size of the mica from the dyke wall outwards.

The mica of the dykes may be muscovite or biotite or both, and is usually associated with beryl, apatite, tourmaline, and garnet.

It is suggested that the dykes owe their present position to the interaction of plutonic solutions with the country rock, and perhaps to a less extent to assimilation. Their occurrence in thousands, many of which are quite small, and arrangement without any common orientation, together with the fact that their mineral content varies with the country rock in which they are found, would lend support to this view.

It is difficult to imagine how such chemical reaction would be responsible for the formation of the vertical zones in the resultant dykes. It is suggested that the zoning is due to two separate igneous emanations, the first rich in felspar molecules, and the second highly siliceous. Assuming that the felspar dykes were first formed, the effect of a highly siliceous solution would be to set up a reaction between the silica and the felspar resulting in the formation of muscovite. It is significant that the largest books of muscovite mica are found along the junction of the quartz and felspar. In suggesting two igneous emanations it is not suggested that there was any great time break between the two. There can be no reason for doubting that the two are genetically related and belong to the same igneous phase.

The reason for assuming that the two divisions of the Oolgarna Acid Intrusives are of the same age and of the same igneous phase, is based largely on the similarity of their felspar content, and the frequent occurrence of graphic granite in both. In only one case in the field was a possible relation between the granite dykes and the pegmatite dykes noted. In this instance a granite dyke in the Augen Schist was separated from a pegmatite dyke in the schist and gneisses by alluvium, but the two were in exact alignment, and it is probable that they were continuous beneath the covering of alluvium.

On the tributary of the Arthur River, about forty miles east of Jervois Range mining settlement, we passed over an outcrop of coarse pink granite very similar in appearance and mineral content to the granite dykes of the plateau. Hematite schist was found associated with the granite. It is entirely surrounded by alluvium, but one is justified in placing it tentatively with the Oolgarna Acid Intrusives.

A few miles west of the Jervois Range mining settlement is a considerable area of tourmaline granite, or perhaps more correctly quartz-tourmaline rock. However, nothing can be said in regard to its relationship with the other rocks. It is placed with the Oolgarna Acid Intrusives provisionally, simply because it does not show any trace of metamorphism, and is similar to some of the quartz-tourmaline dykes of the Marshall River. The tourmaline is the black schorl variety.

v. *The Augen Schist.*—Augen schists occur in the Huckitta Creek Series, but these are not included under this heading. The rock referred to forms a very prominent outcrop (Plate liv, fig. 1) rising to as much as nine hundred feet above the surrounding country, and has been traced for a distance of fifteen miles in a general north-east and south-west direction. Megascopically it has the appearance of a true schist and does not show any of the banding of a gneiss. The "eyes" of this augen schist consist of crystals of microcline, many of which exceed two inches in length.

It is intruded by the Oolgarna Acid Intrusives, but its relation with the Everard Range Granite is quite obscure, as no actual contact with the granite was seen. It definitely intrudes the Huckitta Creek Series, and it is noticeable that where this rock is developed the Huckitta Creek series has been folded to a greater extent than elsewhere.

The Age of the Various Divisions of the Arunta Complex.

From the above description of the various rocks comprising the Arunta Complex, it will be seen that the Huckitta Creek Series represents a vast system of sedimentary rocks with their accompanying igneous rocks, which together have suffered intense though somewhat variable metamorphism. With one possible exception there can be no chronological subdivision of these rocks, as any differences may be due entirely to variation in degree of metamorphism. They are the oldest rocks of the Complex, and are regarded as being of Lower pre-Cambrian or Archæozoic age, being the equivalents of the Yilgarn Series of Western Australia, and the Willyama schists of Broken Hill, N.S.W.

The exception referred to above are some small dyke-like masses of gneiss which may be primary. They may possibly represent the frayed margin of a deep-seated synchronous bathylith. If this suggestion is correct, these gneisses will still be very ancient and should be included in the Archæozoic, though they will be younger than the other members of the Huckitta Creek Series.

It is probable that the Augen Schist belongs here. It intrudes the Huckitta Creek Series, and is intruded by the Oolgarna Acid Intrusives, but its relation to the Everard Range Granite is quite obscure.

The granite gneisses and the Augen Schist are probably the equivalents of the granite gneisses, gabbros, and pegmatites of Archæozoic age of the Barrier Ranges, New South Wales, and the granite gneisses of Western Australia.

In regard to the Ambalindum series, it can only be stated that it is older than the Oolgarna Acid Intrusives. Whether it is Archæozoic or Proterozoic is impossible to determine on the evidence available.

The Everard Range Granite is considered as probably Proterozoic in age and the equivalent of the Late Mosquito granite of Western Australia, and the Mundi-Mundi granite of the Barrier Range of New South Wales. It is of interest to note that north of the Marshall River lenses of ilmenite and rutile were found associated with this granite in the neighbourhood of the largest outcrop of granite seen on this visit. In South Australia at Olary and elsewhere the titanium-rich intrusives of the Houghton magma are also considered as Proterozoic in age. It has been suggested that the silver-lead-zinc deposits of Broken Hill, New South Wales, although occurring in Archæozoic rocks, are in part homotaxial with the Late Mosquito granite. There can be little doubt that the silver-lead-copper deposits of Jervois Range should be correlated with the metalliferous deposits of Broken Hill.

The Oolgarna Acid Intrusives are younger than the Everard Range Granite, and it is probable that they represent the last phase of that intrusion, and they are therefore placed tentatively in the Proterozoic.

The following table gives a tentative correlation of the Central Australian pre-Cambrian rocks with those of Western Australia and New South Wales.

Age.	Western Australia.	New South Wales.		Central Australia.
Proterozoic.	Nullagine Series.	Torrowangie Series.		
	Stirling Range and Mt. Barren Series.			Oolgarna Acid Intrusives (?)
	Late Mosquito granite.	Mundi-Mundi granite.		Everard Range granite.
	Mosquito Series.			Ambalindum Series (?).
Archæozoic.	Kalgoorlie Series.	Willyama.	Granite-gneisses, pegmatites, and grabbros.	Augen Schist granite-gneisses.
	Yilgarn Series.		Schists.	Huckitta Creek Series.

Mineralogy.

The following list of minerals is not intended to be in any way a complete list of minerals occurring in Central Australia. It is merely a list of minerals collected by the party or brought under my notice during our sojourn in Central Australia.

Gold.—The occurrence of gold, alluvial and reef, in the White Range in the vicinity of Arltunga has long been known and an excellent description of the various occurrences is given by Mr. H. Y. L. Brown.[15] I was not able to examine any of the occurrences, but I was shown a number of gold specimens, including alluvial nuggets weighing up to approximately five pennyweights, brought in by aborigines. The gold that I saw is somewhat paler than that typical of the eastern States. According to Brown, it is alloyed with silver.

Galena.—This mineral occurs at Jervois Range in lenses as already described. It is the massive cleavable variety but nothing in the nature of crystals was seen. It is argentiferous, assaying up to ten ounces of silver per ton. Galena is also found in the auriferous reefs at Arltunga, but does not appear to exist in any quantity.

Chalcocite.—The Green Parrot Shaft, Jervois Range, passes through a lense of ore which consists largely of massive chalcocite.

Covellite.—This mineral occurs as a coating on chalcopyrite, which impregnates the muscovite-sericite schist at Jervois Range.

Bornite.—A small lense of massive bornite was seen at Jervois Range.

Chalcopyrite.—This mineral is found at Jervois Range as small segregations or eyes and as impregnations in the schist. One of the "eyes" measured eight

[15] Brown, H. Y. L.—Reports on Arltunga Goldfield, etc., South Australia, 1897.

inches in length and three and a half inches along the greatest diameter. It is also found associated with galena and pyrite.

In the auriferous reefs at Arltunga, and a small reef four miles south-west of the road crossing at Huckitta Creek, small disseminated grains of chalcopyrite are found in quartz.

Pyrite.—This mineral was found only sparingly at Jervois Range. Blowpipe tests carried out proved that it is in part cobaltiferous.

Fluorite.—This mineral was found only at Jervois Range, where it occurs as crystalline incrustations associated with crystals of quartz. Unfortunately I did not see the mineral *in situ* and the specimens were all badly broken. The colour varies from purple to heliotrope.

Quartz.—Although there are a great number of very large masses of pure white quartz occurring between Jervois Range and Alice Springs, no really good specimens of quartz crystals were obtained. Small prismatic crystals of colourless quartz were seen associated with fluorite at Jervois Range. At the junction of the Florence and Hale Rivers a small prismatic crystal was found in a vugh in a boulder of limestone.

Hematite.—A band of micaceous hematite is associated with a coarse pink granite near a tributary of the Arthur River, some eleven miles west of the Tarlton Range. An excellent specimen of mammillary hematite, said to have come from 179 miles south-east of Alice Springs, was secured.

Magnetite.—A band of massive magnetite was seen cutting one of the lenses of ore at Jervois Range. A small band, varying from one to three inches in thickness, striking parallel to the schist was found in garnetiferous mica-schist near the Mammoth Mine, four miles south-west of the road crossing at Huckitta Creek.

Ilmenite.—This mineral was found associated with a little rutile a few miles north of the Marshall River. It occurred as pressure lenses in schist and as detrital material.

Rutile.—Only a very small quantity associated with the ilmenite was found. It was a reddish-brown colour.

Manganese oxide.—Some gossanous manganese oxide was found on the outcrop of one of the lenses of ore at Jervois Range. A small band of pisolitic pyrolusite (?) associated with quartzite was obtained at a well some twenty-four miles west of Tobermory Station.

Calcite.—Some small crystals measuring up to two millimetres in diameter were found lining a vugh at the same locality as the pisolitic pyrolusite. Only two forms were present, $b(11\bar{2}0)$ and $f\cdot(11\bar{2}2)$. A small piece of Iceland spar was picked up in a creek close to an outcrop of altered limestone near the Mammoth Mine. The numerous outcrops of limestone and altered limestone have already been described.

Dolomite.—A bed of dolomite, associated with limestone, some twenty-six miles south-west of Tobermory Station, is the only occurrence met with.

Cerussite.—At Jervois Range cerussite was found at the surface to a few feet below. It occurs both massive and reticulated, associated with fibrous malachite

in quartz. Some of the massive material is a steel grey colour, otherwise it is white in colour.

Sphærocobaltite.—Only one specimen of this mineral was obtained from the outcrop of Jervois Range lode, and this constitutes the first record of this mineral in Australia. It occurs as a thin coating on malachite and azurite. The surface of the coating is more or less mammillary, with, in places, a tendency to crystalline structure. It has a vitreous lustre, a rose red colour, and is translucent. The hardness is nearly 5. It effervesces freely in warm acid. In the closed tube it turns black and no water is given off. Unfortunately there is not enough material to carry out a quantitative chemical analysis. The mineral does not show any tendency to alteration as indicated by Dana.[16] The rock which is coated by the mineral contains cubes of cobaltiferous pyrite.

Malachite.—Jervois Range was the only locality at which this mineral was collected. It is associated with earthy limonite, chalcocite, sphærocobaltite, cerussite, azurite, and quartz. It occurs incrusting fibrous, and as slender prismatic crystals grouped as radiating or diverging.

Azurite.—Like malachite, with which it is mostly associated, azurite was found only at Jervois Range. It occurs as crystalline crusts and veins, but no crystals were obtained sufficiently good to measure. It is also found earthy.

Bismutite.—One specimen of this mineral was given to me at Alice Springs as coming from west of that town. The bismutite occurs in quartz and is a yellowish-green colour. The lustre is mostly vitreous, but sometimes dull.

Felspar.—Very large masses of felspar occur in the dykes of Oolgarna Acid Intrusives. Very crude stout prismatic crystals of microcline weather out from the Augen Schist, but they are quite unsuitable for measurement. As previously pointed out, felspar occurs in enormous quantity as a constituent of many of the rocks of the Arunta Complex. The different species of felspar arranged in their approximate order of abundance are as follows: Microcline, perthite (mostly microperthite), plagioclase, and orthoclase. A few chains west of the Mammoth Mica Mine is a small dyke containing some typical moonstone.

The microcline from a dyke three miles north of the Mammoth Mine was analysed by Mr. R. O. Chalmers, with the following result:

SiO_2	65·21
Al_2O_3	19·62
Fe_2O_3	Trace
CaO	Absent
MgO	Absent
Na_2O	3·65
K_2O	11·99
	100·47
Specific gravity	2·58

[16] Dana, E. S.—System of Min., 6th edition, 1892, p. 280.

Diopside.—Beside occurring as disseminated grains in altered limestones (Ambalindum Series), this mineral is found in granular masses associated with quartz forming veins in the altered limestone. The colour is pale green and the mineral belongs to the coccolite variety of diopside.

Beryl (Figure 6).—This mineral has been found only in the Oolgarna Acid Intrusives, and is generally associated with mica, sometimes as inclusions in the mica crystals. Very large crystals have been recorded from Central Australia, but the largest seen by me was 22·5 cm. in diameter. Unfortunately, it had been broken, but I was informed that it was about two feet (60 cm.) in length. Beryl of gem quality appears to be almost entirely absent. One beautiful crystal some 8 cm. in diameter and 17 cm. in length was in the main of gem quality. The colour of the mineral varies considerably, from various shades of green to ultramarine and pale greyish-blue to almost white. The only forms present on the crystal were two prisms and a basal plane.

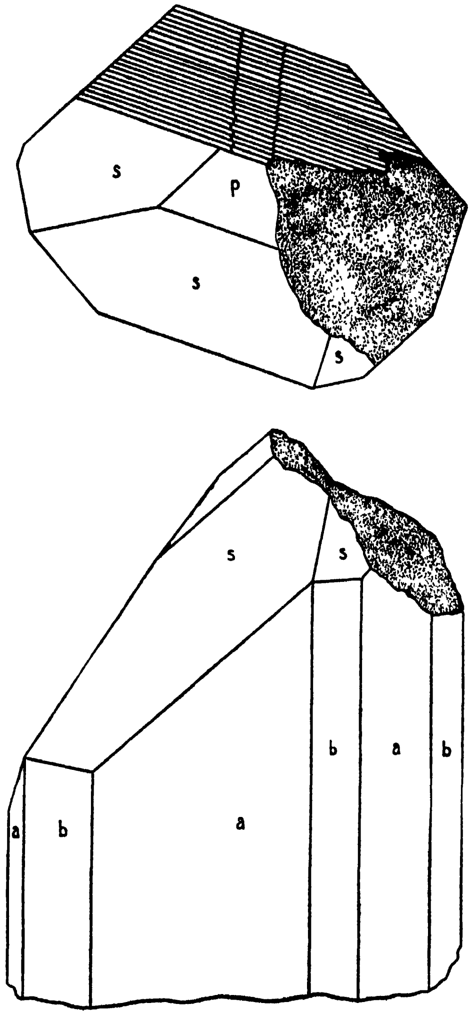

Fig. 6.—Beryl, Hart Range, Central Australia. *Forms.*—$a(10\bar{1}0)$, $b(11\bar{2}0)$, $s(11\bar{2}1)$, and $p(1\bar{1}01)$.

Only one crystal was found with terminal faces other than the basal plane. It was somewhat distorted and broken, measuring 11 mm. × 15 mm. × 36 mm. It was measured on a two-circle goniometer. The following forms were present: $a(10\bar{1}0)$, $b(11\bar{2}0)$, $p(10\bar{1}1)$, and $s(11\bar{2}1)$. Of the prism forms, $a(10\bar{1}0)$ gave good signals, while $b(11\bar{2}0)$ gave a very bad signal or no signal at all, with the exception of one face which gave a fair signal only. Of the pyramids, $p(10\bar{1}1)$ is represented by two faces and $s(11\bar{2}1)$ by five; the signals of the faces of these two forms are only fair. The crystal is prismatic in habit, one-half distorted by the alteration of the prism and pyramid faces.

The following table gives the measured and calculated ϕ and ρ angles:

Form.	Measured.				Calculated.				Error.	
	φ		ρ		φ		ρ		φ	ρ
	°	′	°	′	°	′	°	′	′	′
$a(10\bar{1}0)$	0	0	90	0	0	0	90	0	0	0
$b(11\bar{2}0)$	29	56	90	0	30	0	90	0	4	0
$s(11\bar{2}1)$	29	57	45	3	30	0	44	56	3	7
$p(10\bar{1}1)$	0	31	29	48	0	0	29	57	31	9

Garnet.—This mineral is found in great profusion in the rocks of the Arunta Complex, particularly in the schists and gneisses of the Huckitta Creek Series.

In the schists and gneisses good crystals are rare; more often they are distorted, fragmental, or rounded. The icositetrahedron $q(211)$ is the commonest form, less often the rhombic dodecahedron $d(110)$, and only rarely the combination of these two forms is found. Except in a very few restricted localities, the garnet is not of gem quality, being opaque with a brownish-red colour. Crystals up to 40 mm. are common.

Both the opaque and gem varieties have been analysed with the following result:

	Opaque variety.		Gem variety.
SiO_2	39·23	..	38·33
Al_2O_3	23·54	.	21·52
Fe_2O_3	3·24	..	1·11
FeO	27·75	..	31·95
MgO	5·69	.	5·87
CaO	1·23	..	0·95
MnO	0·19	.	0·15
	100·87	..	99·88
Specific gravity	4·08	..	3·98

Analyst: R. O. Chalmers.

From the above results it will be seen that the two varieties occurring in the schists and gneisses are almandite.

In the Oolgarna Acid Intrusives the garnet is similar in habit to that found in the schists and gneisses, but more often approaches gem quality, when it often exhibits the rhombic dodecahedral parting. It was in one of these dykes at the mica mine of Mr. J. Lewis, about twenty miles south-west of the Plenty River road crossing, that the largest crystal of garnet was found. It measures approximately 27 cm. in diameter. Though somewhat distorted, the rhombic dodecahedron $d(110)$, the icositetrahedron $q(211)$, and the hexakis octahedron $x(321)$ were easily recognizable. The crystal was black on the outside and very dark red to nearly black on fresh fracture. The faces on one side of the crystal were lost in removing the crystal from the quartz and felspar in which it was embedded.

As inclusions in the mica of these dykes the garnet (Figure 7) was often tabular parallel to a face of the icositetrahedron $q(211)$. These crystals varied

from red to brownish-red and many of them were perfectly clear.

Two of these crystals were measured on a two-circle goniometer and found to give only fair signals. The forms present were the rhombic dodecahedron $d(110)$, and the icositetrahedron $q(211)$, while the hexakis octahedron $x(321)$ was represented by one exceedingly small face in one crystal. They owe their peculiar habit to the conditions under which they were formed. All the faces are striated in conformity with the cleavage of the mica in which they are enclosed. The tabular faces are always parallel to the direction of the cleavage of the mica, and are striated parallel to the edges $q{:}q$ and $d{:}d$.

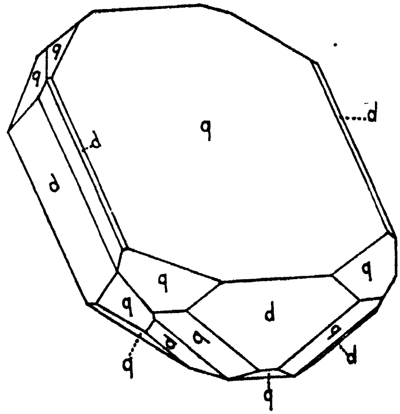

Fig. 7.—Garnet found as inclusions in mica, Hart Range, Central Australia, drawn in the conventional position showing the peculiar habit, tabular to the icositetrahedron. *Forms*: $d(110)$ and $q(211)$.

Grossularite was found as brown crystals in the altered limestone of the Ambalindum Series.

Cyanite.—A fragment of a crystal was given to me as coming from the mica fields. It is transparent except in the centre, where the colour is a deep blue; elsewhere the colour is pale green.

Anthophyllite.—Only one specimen of this mineral was secured, and this was given to me as a specimen of asbestos coming from a locality eleven miles up Huckitta Creek from the road crossing. It has the typical appearance of asbestos, and the longest fibres in the specimen are 22·5 cm. in length, but they are somewhat brittle. The mineral was analysed by Mr. R. O. Chalmers with the following result:

SiO_2	57·10
Al_2O_3	0·37
FeO	8·94
CaO	1·52
MgO	28·08
Loss on ignition	3·56
	99·57
Specific gravity	3·00

Epidote.—Only a very little of this mineral was seen in the various localities in the Hart Range. It is the usual yellowish-green variety associated with quartz and felspar of the Oolgarna Acid Intrusives.

Tourmaline.—This mineral (Figure 8) is of fairly wide distribution in the Arunta Complex. It is found in the Hart Range in the Oolgarna Acid Intrusives, sometimes as inclusions in crystals of mica, and the schist of the Huckitta Creek Series. At Jervois Range it occurs in immense quantities as black schorl associ-

ated with quartz. On the Marshall River it is found in beautiful crystals; though I was unable to visit the locality, some very fine specimens were kindly

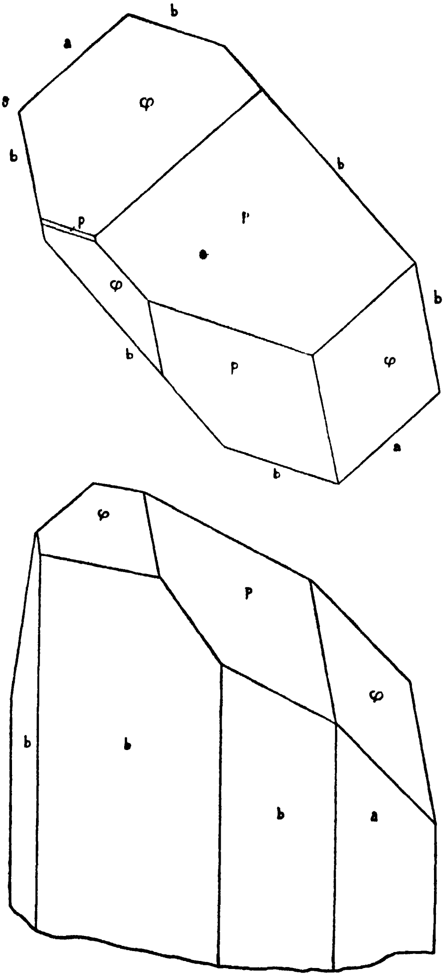

Fig. 8.—Tourmaline, Marshall River, Central Australia. *Forms*: $a(10\bar{1}0)$, $b(11\bar{2}0)$, $\theta(41\bar{5}0)$, $p(1\bar{1}21)$ and $\phi(\bar{2}\bar{2}41)$.

given to me by Mr. Lewis. In one of these specimens the tourmaline was associated with apatite, muscovite, quartz, and felspar, so that it evidently occurs here in the Oolgarna Acid Intrusives. The colour of the mineral is invariably black.

Three crystals from the Marshall River were chosen for measurement on a two-circle goniometer. The following seven forms were recognized: $a(10\bar{1}0)$, $b(11\bar{2}0)$, $\eta(21\bar{3}0)$, $\omega(31\bar{4}0)$, $\theta(41\bar{5}0)$, $p(11\bar{2}1)$, and $\phi\cdot(\bar{2}\bar{2}41)$. In one crystal a steep scaleno-

hedron is present giving ϕ and ρ angles of 13° 47′ and 85° 32′, which corresponds to an unrecorded form $(21 \cdot 7 \cdot \overline{28} \cdot 1)$, the calculated ϕ and ρ angles of which are 13° 54′ and 85° 37′. The following table gives the results of the measurements made:

Form.	Measured.				Calculated.				Error.	
	φ		ρ		φ		ρ		φ	ρ
	°	′	°	′	°	′	°	′	′	′
$a(10\bar{1}0)$	0	0	90	0	0	0	90	0	0	0
$b(11\bar{2}0)$	30	0	90	0	30	0	90	0	0	0
$\eta(21\bar{3}0)$	20	3	89	27	19	6	90	0	57	33
$\omega(31\bar{4}0)$	13	45	90	0	13	54	90	0	9	0
$\theta(41\bar{5}0)$	11	6	89	57	10	53	90	0	13	3
$\gamma(11\bar{2}1)$	0	4	27	25	0	0	27	20	4	5
$\varphi'(\overline{22}41)$	0	3	46	5	0	0	45	47	3	18
$(21 \cdot 7 \cdot \overline{28} \cdot 1)$	13	47	85	32	13	54	85	37	7	5

Mica.—Muscovite and biotite were the only two species of this group of minerals that were definitely recognized in the area, and it is proposed to describe them separately.

Muscovite.—Beside being a constituent of many rocks of the Arunta Complex, muscovite is found as crystals or "books" in the very acid dykes of the Hart Range and Plenty River area. The crystals vary in size from a few millimetres to as much as a metre or more in diameter. In the large books no definite crystal outline is developed, but in the smaller ones the cross-section is mostly hexagonal, though often the form *b*(010) is very poorly developed, giving the crystal an orthorhombic appearance. The larger crystals are usually stout tabular in habit, while the smaller ones are frequently prismatic with the prism zone tapering toward the basal plane and strongly striated horizontally. The basal plane is invariably rough, and when exposed to the surface is generally much weathered.

The colour of the muscovite varies considerably, there being various shades of reddish-brown, amber, and green. The optical axial angle varies with the colour as follows:

Colour of the Muscovite.	2E.
Amber	64° 20′
Reddish-brown	68° 15′
Green	73° 55′

In addition to the usual perfect basal cleavage, there is occasionally a cleavage or parting parallel to a clino-pinacoid. On splitting this type of mica, narrow strips are produced instead of the usual plates or leaves, and this variety is known on the field as ribbon mica.

Gliding planes produced by pressure have been noted only rarely, and when present correspond approximately to the planes $\rho(205)$ and $\zeta(135)$, accurate measurement being impossible owing to the formation of fibrous mica along these planes.

A highly polished plane occurred in one crystal of mica quite different from any of the partings or gliding planes described above. It lay in the zone [100], and the angle between it and the basal cleavage is 8° 30′. It is probably a vicinal face.

Another feature produced by pressure, not infrequently observed, is the regular rippling of the mica in directions parallel to the prism faces *m*(110), with a further irregular line of rippling at the angle where the two sets of ripples meet. The ripples are quite distinct and can be felt by the fingers. It often happens that hematite is deposited along the ripples, thus emphasizing the effect. A book of mica, say, ten centimetres thick, may show no sign of this structure until being split, when it will be found to be affected in a small central zone only.

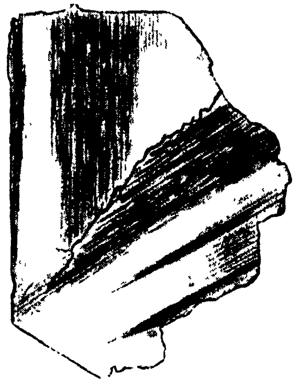

Fig. 9.—Mica, Hart Range, Central Australia, showing rippling parallel to the prism.

What may be regarded as an intergrowth with biotite was seen in only two specimens. The central portion of a small crystal was composed of muscovite followed by biotite and again by muscovite (Figure 10).

Crystals of muscovite are often included in larger crystals of the same mineral. An examination of a large number of specimens proves that the orienta-

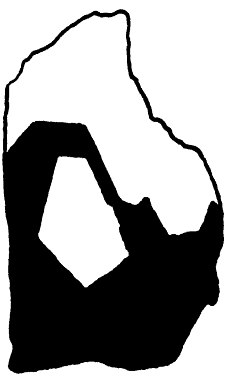

Fig. 10.—Mica, Hart Range, Central Australia, showing intergrowth of muscovite and biotite.

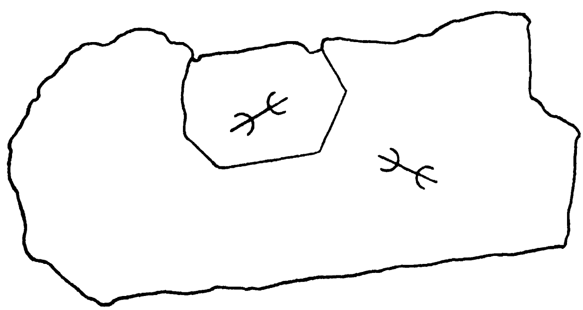

Fig. 11.—Mica, Hart Range, Central Australia, showing the relation of the optical orientation of the included crystal to the host.

tion of the included crystal may bear any relation to that of the host. Occasionally the basal cleavage of the two may be parallel, but it is found that the optical axial planes of the two as observed in a number of cases bear no constant relation to one another, though in one case (Figure 11) the relative positions of the two axial planes are suggestive of twinning according to the mica law. Otherwise no actual twinning has been recognized.

One of these included crystals, measuring 11 mm. by 18 mm. by 24 mm. along the *a*, *b* and *c* axes respectively, was translucent in the direction of the horizontal axes, the colour by transmitted light being green. This interesting crystal was included in a crystal of reddish-brown muscovite measuring approximately 28 cm. in diameter, and was the only one of its kind that was observed.

Crystals of biotite are sometimes included in the same manner as those of muscovite. Quartz is another common inclusion, and is generally in the form of flat plates lying parallel to the direction of cleavage of the mica. Often these plates are extremely thin, but they have been found up to 1 cm. in thickness. The quartz may also occur in more or less irregular masses with no relation to the cleavage of the mica whatever. When beryl is found as an inclusion it is invariably associated with these irregular masses of quartz. Other inclusions noted include garnet, tourmaline, and apatite. Magnetite in the form of regular dendritic markings, so common in mica, is often present.

Biotite.—The occurrence of this mineral is the same as that of muscovite. The books of biotite seldom show any crystal outline, but are more in the nature of foliated masses from which it is impossible to split thin plates. Books up to 50 cm. were observed, but the largest cleavage plate obtained measured 19·5 cm. by 15·5 cm., and, so far as my observations went, this was a unique specimen.

Chrysocolla.—This mineral occurs in enamel-like masses and veins impregnating the country rock, and also associated with chalcopyrite, malachite, and cuprite near the Green Parrot Shaft, Jervois Range.

Apatite.—I can find no previous record of this mineral, although it occurs fairly frequently in the Oolgarna Acid Intrusives of the Hart Range. The best specimens were collected from two localities, one eight miles south of Harding Springs, and the other sixteen miles north of the same locality. In the former case it was not seen *in situ*, but Mr. Mace, the owner of a mica mine there, showed me several pieces measuring up to 5 cm. in diameter, one of which he presented to the museum. This material is bottle green in colour, translucent, with a vitreous lustre. It has well developed prismatic and basal cleavages. It was thought to be olivine or green felspar by the miners on the field. The chemical composition is as follows:

CaO	54·88
MnO	1·72
P_2O_5	41·85
F	Absent
Cl	1·34
H_2O	0·36
	100·15
Specific gravity	3·17

Analyst, T. H.-S.

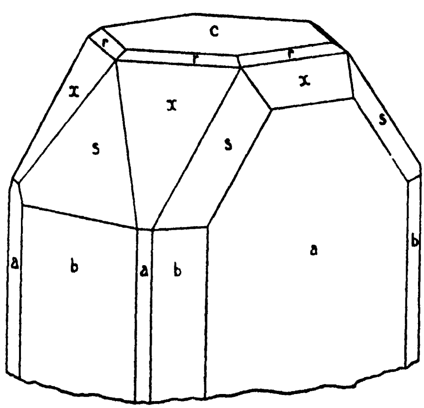

Fig. 12.—Apatite, Hart Range, Central Australia. *Forms*: $c(0001)$, $a(10\bar{1}0)$, $b(11\bar{2}0)$, $r(10\bar{1}2)$, $x(10\bar{1}1)$, and $s(11\bar{2}1)$.

From the above analysis it will be seen that the mineral belongs to the chlorapatite variety, with a notable amount of manganese present. This is

remarkable, as the manganese-bearing apatites appear to be generally rich in fluorine, which is entirely absent in this mineral.

From the latter locality two small crystals were obtained associated with mica of a pegmatite dyke. The crystals measured 10 mm. by 8 mm. by 10 mm., and 6 mm. by 7 mm. by 7 mm. The prisms $a(10\bar{1}0)$ and $b(11\bar{2}0)$ were present and the forms $r(10\bar{1}2)$, $x(10\bar{1}1)$, $s(11\bar{2}1)$, and $c(0001)$ comprised the single termination in each case. Both crystals were measured on a two-circle goniometer and except for the prisms and basal plane, the signals were bad, merely serving to identify the forms present. This appeared to be due to an exceedingly fine etching of the faces. The arrangement of the prism faces is peculiar in that it produces a rectangular cross-section of the crystal rather than the usual hexagonal form.

Pyromorphite.—This mineral was found only on the surface just north-west of Hanlan's Reward Shaft, Jervois Range, where it was exposed more or less to the action of atmospheric weathering. It occurred as groups of prismatic crystals deposited on a ferruginous somewhat gossanous rock. Much of the pyromorphite was weathered on the surface only to a light brown to almost black colour. The true colour varies from yellow to yellowish-green. No crystals were suitable for measurement, and the only termination noted was the basal plane.

Niter.—I was able to secure two specimens of this mineral, although I did not visit the locality, which is south of Mt. Zeil and 120 miles due west of Alice Springs. Its mode of occurrence, origin, etc., has been fully described by Sir Douglas Mawson,[17] so that any comment would only be in the nature of repetition.

Summary.

From the Queensland border (lat. 21° south) to Jervois Range the country is essentially plane relieved only by flat-topped hills of level-bedded Cretaceous (?) rocks, and the Tarlton Range of possibly Palæozoic rocks. Otherwise the rocks are mostly covered by alluvium, but near the Queensland border Palæozoic rocks dipping to the west were seen. Beyond the Tarlton Range pre-Cambrian rocks appear here and there through the alluvium.

Jervois Range is a steep fault scarp separating the plane country from the Central Australian Plateau which consists of pre-Cambrian rocks, the Arunta Complex, flanked to the north and south by Palæozoic rocks, with occasional outliers on the plateau itself.

The Arunta Complex has been divided into the Huckitta Creek Series, correlated with the Yilgarn of Western Australia; the Ambalindum Series of doubtful age; the Everard Range Granite, forming a bathylith and the equivalent of the Late Mosquito Granite of Western Australia; and the Oolgarna Acid Intrusives, which may possibly represent the last phase of the Everard Range Granite.

At Jervois Range cerussite, pyromorphite, chalcocite, cobaltiferous pyrite, and fluorite were among the minerals collected, while sphærocobaltite constitutes the first record of this mineral in Australia.

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[17] Mawson, D.—Min. Mag., xxii, 1930, pp. 231-237.

From the mica-bearing dykes of the Hart Range crystals of beryl, tourmaline, garnet, and apatite have been measured and described. The mica consists of muscovite and biotite, the former occurring in sufficient quantity and quality to be of considerable commercial importance.

EXPLANATION OF PLATES.

Plate LIII.

Fig. 1.—The plane country near the Queensland border at about latitude 21° south. The timber is gidyea.

Fig. 2.—The limestone capping of one of the flat-topped hills found in the eastern part of Central Australia.

Fig. 3.—Goyder's Pillars at the northern end of the Tarlton Range, Central Australia, showing the dissection of the range into mesas.

Fig. 4.—Oorabbra Water Holes. This is the largest outcrop of the Everard Range Granite seen during the Expedition.

Fig. 5.—A dyke of the Oolgarna Acid Intrusives left standing as a result of differential erosion. Near Oorabbra, Central Australia.

Plate LIV.

Fig. 1.—A view of the Hart Range, Central Australia. The larger peak on the skyline is part of the outcrop of the Augen Schist. The section in text-figure 4 is taken through this peak toward the observer. The main Camp was situated in front of the small hill in the centre middle distance.

Fig. 2.—Quartz and pegmatite dykes of the Oolgarna Acid Intrusives cutting through the Huckitta Creek Series near the Mammoth Mine, Hart Range. The dykes are seen as white patches, while on the extreme left of the picture is seen one of the dykes left standing as a wall of white quartz, as a result of differential erosion.

Fig. 3.—A natural east-west section of the Huckitta Creek Series looking north, at the road crossing, Huckitta Creek, Central Australia.

Fig. 4.—An example of *lit-par-lit* injection of gneissic granite, Huckitta Creek, Central Australia.

Plate LV.

Fig. 1.—The Augen Schist showing the "eyes" of microcline. Hart Range, Central Australia.

Fig. 2.—Contorted gneiss, Hart Range, Central Australia.

PLATE XLVII.

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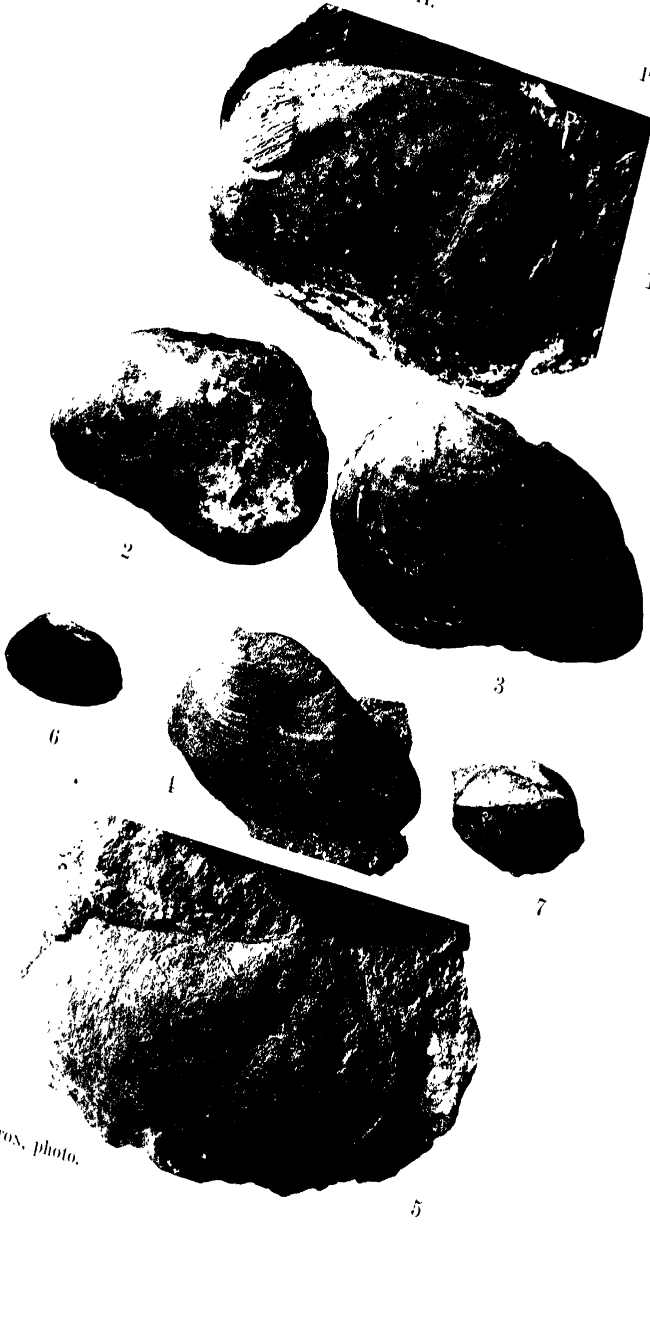
G. C. CLUTTON, photo.

PLATE XLVIII.



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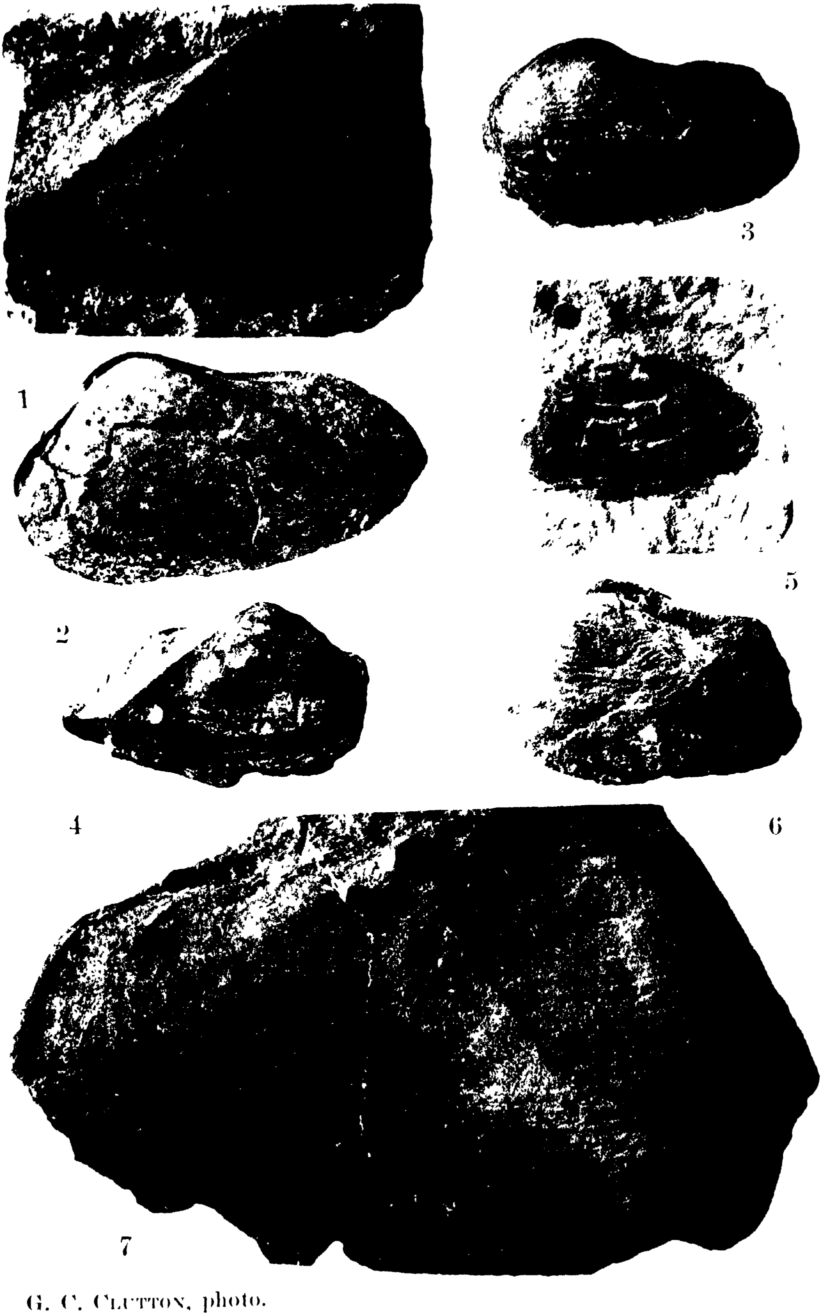

G. C. CLUTTON, photo.

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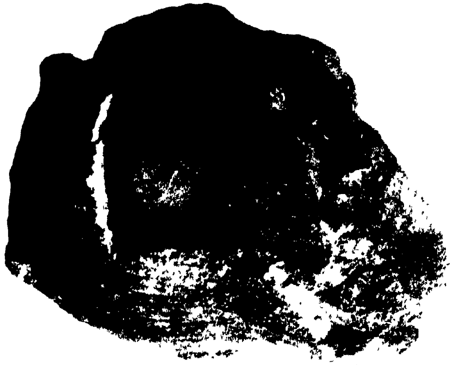

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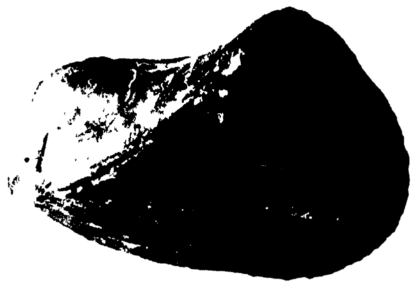

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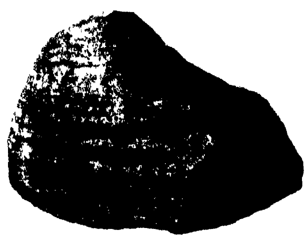

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G. C. CLUTTON, photo.

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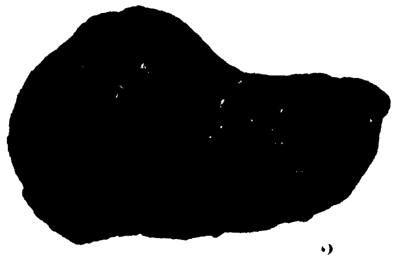

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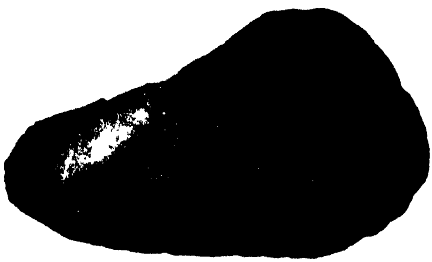

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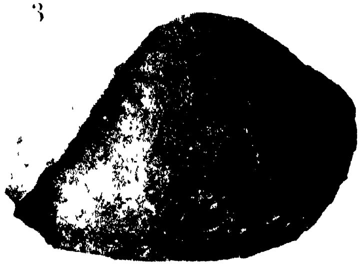

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G. C. CLUTTON, photo.

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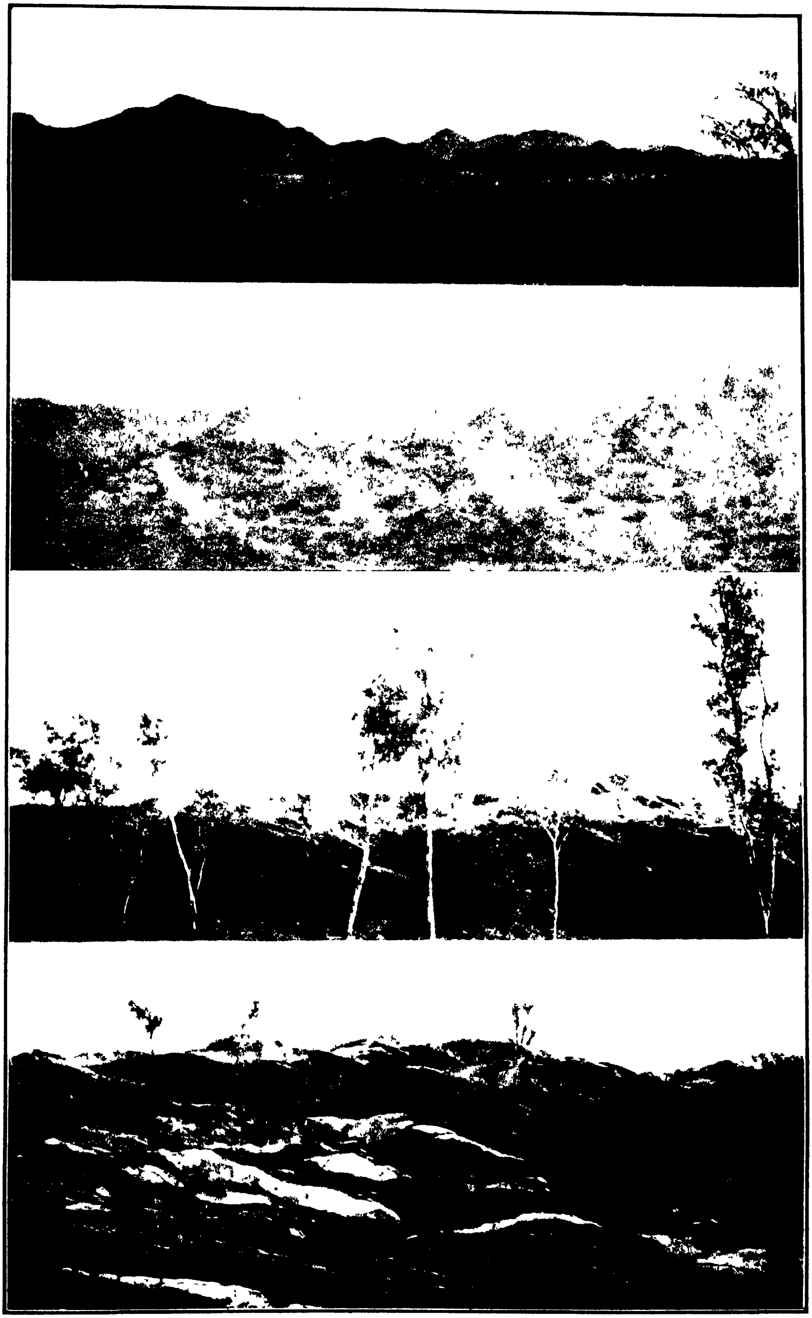
T. HODGE-SMITH, photos.



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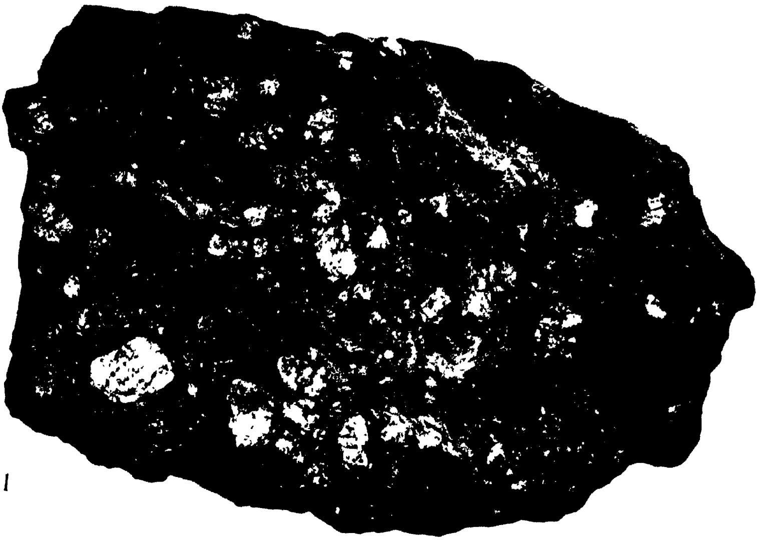

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G. C. CLUTTON, photos.

OPISTHOBRANCHS FROM AUSTRALIA.

By

JOYCE K. ALLAN,

Assistant in Conchology, The Australian Museum.

(Plate lvi.)

In the following paper Opisthobranchs are described from Australia generally. Notes had been made on these either at the time of collecting, or when they were brought alive to the Museum, so that observations on them and records of their correct colours would be available for future reference. In this way, many useful notes on other new or uncommon species have accumulated, and are ready to be converted into more complete descriptions when the preserved animals are thoroughly examined.

If little work has been done on the Australian Nudibranchs, still less has been done on the Opisthobranchs generally, though the coast of Australia should be rich in this order, particularly in the northern regions. I therefore think it will serve a better purpose to publish what material I have ready for publication in small papers than to accumulate it for a larger paper.

My thanks are due to those who are mentioned in the text for their kindness in collecting and carefully preserving specimens for me.

Suborder TECTIBRANCHIATA.

Family AGLAIIDÆ.

Genus **Aglaia** Renier, 1804.

Aglaia Renier, Prospette delle Classe dei Verme, p. 16 (1804); Tav. di Classificazione, 1807, Pl. 8. *Fide* Pilsbry, Man. of Conch. [Tryon], Vol. xvi, 1895-6, p. 44. Type of genus here designated *Aglaia tricolorata* Renier.

Animal smooth with a soft body separated into two dorsal shields by a transverse furrow. The posterior one produced to form two lobes. The foot is wide and truncated, and the sides either stand erect or extend over the sides of the body as fleshy folds. No rhinophores or frontal head appendage. A flat shell with a slightly spiral whorl and minute spire is at the posterior end. Gill plume large, placed posteriorly on the right side. Buccal mass conspicuous, no jaws or radula.

The generic name *Aglaia* was first definitely given by Renier in 1807 to two species from the Mediterranean, but as Pilsbry (Man. of Conch. [Tryon], Vol. xvi, 1895-6, p. 44) points out, without any justification the name adopted by authors generally was *Doridium* of Meckel, 1809. He considers *Philinopsis* of Pease, for a Sandwich Islands' species, a synonym of *Aglaia*.

Though the latter name was given to a Mediterranean species, I cannot find any characters in the species described below to warrant making a new genus for them. As I had only a single specimen for each species, I think it advisable to leave them in the genus *Aglaia* until I have more specimens. My species may be nearer those of Pease's genus, of which there is only a brief description, and which Pilsbry considers a likely synonym of *Aglaia*.

Aglaia taronga, sp. nov.

(Plate lvi, figs. 1–3.)

Animal large, very soft and smooth, broad at the anterior end. Posterior disk is shorter than the anterior one, evenly lobed on either side. The anterior dorsal disk is produced to a rounded point posteriorly, which the animal erects when in motion. The foot extends the whole length of the body, reaching to the margin of the dorsal surface for some distance, then expanding into lobes, until it reaches its greatest width near the gills; the lobes curl up over the sides of the animal. Mouth large and rounded, orals hidden. Shell situated at hinder portion just above the gills. It is straw coloured towards the centre, whitish towards the margins, convex externally, concave internally, with a slight volution and a broad membranous expansion.

The colour of the animal in life is rich velvety dark brown, with sometimes a bluish bloom over it. The sides of the lobes are outlined with a thin hairline of white with a dark inner brown band. The tail lobes are also outlined with white. A thin interrupted central line of white, becoming spotted in places, runs down the centre of the body towards the posterior point of the anterior disk, and then down to the hinder disk. A line of white, then a line of brown, are on the sides of the anterior disk. Down each side is a rich orange yellow stripe, wide at the top, thinning out as it approaches the end and becoming paler. The posterior point of the anterior disk is very dark in colour, with a small orange spot on the apex and orange dots extending from it up the sides. A streak of orange dots is on the head on each side of the central whitish line, and an irregular row of orange spots and dashes round the body lobes, just below the dark band. A broad band of orange is on each side of the tail lobes, below the dark colour. Over the whole surface of the body are scattered patches of small creamy-white splashes. Single dots are arranged round the yellow marks on the head. The sides of the lobes have larger creamy-yellow markings covering them.

Inside the lobes are transparent whitish-grey covered with white and orange spots. There is a black border round the edge with a white hairline. Black towards the top with a row of white dots larger than the others.

The undersurface is dark velvety purplish-brown, with cream spots and dashes, especially thick at the sides. The margins are outlined with a row of yellow dots and dashes. The anterior margin is very dark. The gill is pale yellow.

Length of animal 65 mm., breadth 26 mm. Shell almost circular, 10 mm. × 9 mm. Type, Australian Museum.

Locality.—Athol Bay, Sydney Harbour. A single specimen was caught in a 125 foot net by the staff of the aquarium at Taronga Park, in about 10 feet of water, 300 yards from the shore, and presented to the Museum in April, 1931.

Aglaia sanguinea, sp. nov.

(Plate lvi, figs. 6–8.)

Animal very small, soft and smooth, oblong truncate at the anterior end, tapering posteriorly. Anterior disk about the same length as the posterior. The latter tapers off towards the tail, and ends in two lobes, the left much longer than the right. The foot extends to the smaller lobe and its pleuropodial lobes are wide and fleshy. Gill posterior, bipinnate, on the right side between the shell and the foot. The head is represented by small lobes on each side of the mouth, which is large and rounded.

Shell internal, situated in posterior dorsal disk towards the right lobe. It is large for the size of the animal, being about one-fourth the size of the whole animal and fills the greater part of the hinder disk. It is arched and swollen, with curved lines and some slight transverse ones.

In life the animal is a beautiful blue-black colour with rich blood-red spots of different sizes irregularly scattered over the surface. A large spot surrounded by smaller ones is on the head, and a wavy interrupted line extends a little way down the centre of the anterior disk. Down the centre of the long and short lobes of the posterior disk are rows of about six and four respectively larger red spots. Gill pale.

The undersurface is the same colour as the upper, with white spots thickly scattered over the foot. A row of blood-red spots outline the anterior end of the foot and two large ones are on the longest lobe.

The shell is light brown at the apex and paler towards the sides. Inside, the coiled portion is white, the expanded portion light brown.

Length of animal 13 mm., breadth 6 mm. Shell, 3 mm. long, 2 mm. broad.

Type, Australian Museum.

Locality.—A single specimen found under stones in a rock-pool at Long Reef, near Sydney, New South Wales, by Messrs. T. Iredale and G. P. Whitley in November, 1931.

Family PLEUROBRANCHIDÆ.

Genus **Pleurobranchæa** Leue, 1813.

Pleurobranchæa Leue, de Pleurobranchæa novo Molluscorum Genere, Diss. Inaug., 1813, p. 1–13. Type of genus by present designation, *Pleurobranchæa meckelii* Blainville.

Body oblong, mantle and head smaller than foot. The veil serrated in front and produced into expansions laterally. Rhinophores are situated far apart on the edge of the mantle near the neck portion. The mouth forms a prosboscis. There is a gland on the posterior part of the sole of the foot. The mantle overhangs only on the right side. The mantle folding over the end of the gill produces a siphon. There is no shell. Other characters are the same as those of the genus *Pleurobranchus*. Only a few widely distributed species known.

Pleurobranchæa dorsalis, sp. nov.

(Plate lvi, figs. 4–5.)

Animal oblong, mantle produced forward into a large head with a lateral projection on each side. Mantle not projecting, covering only the central portion

of the animal. Edges slightly wavy. Rhinophores conspicuous, situated on mantle near the neck and far apart, slit, and rolled. Foot very large and expansive, truncate in front and produced far beyond the mantle to a rounded tail. Gill rather small, bipinnate, inserted about the middle of the mantle between it and the foot.

Colour of the animal in life was a rich purplish-brown. The ground colour was lighter brown with darker purplish tinges over the mantle and main portions of the head flaps. There are dark purplish patches on the foot. Over the whole surface is a fine network of black reticulations. Rhinophores are light brown. Small white patches are scattered over the surface, especially round the head and sides and posterior end of mantle near the siphon. Gill plume pale. Foot paler, with dark patches, junction of foot and mantle dark.

Length of animal 40 mm., width 20 mm.

Locality.—Several specimens were dredged in a few fathoms of water at Yarra Bay, Botany Bay, near Sydney, by Mr. Tom Iredale in October, 1927. Specimens have been found also at Bottle and Glass Rocks, Sydney Harbour, in 4–5 fthms.

The specimens from Botany Bay were placed in the aquarium at the Australian Museum, where they laid some eggs. The egg-coil was a single circular convolution about 30 mm. across, the actual girdle containing the eggs being 90 mm. long and 5 mm. wide. It was dead white in colour and the eggs were enclosed in capsules arranged in irregular rows, which showed through as dark tracings. The egg-girdle took about one and a half hours to lay.

Sixteen days after laying, black specks were noticed in the girdle and when this was examined under the microscope the embryos were seen whirling furiously round in the capsules. A few days later these had all dispersed in the water. The slugs disappeared before they could be preserved, but notes and colour sketches had previously been made.

Only one species of *Pleurobranchæa* had previously been recorded from eastern Australia, *P. maculata* Q. & G., which, however, is quite distinct from the species described above. The latter somewhat resembles in colour the New Zealand *P. novæzealandiæ* Cheeseman.

Suborder NUDIBRANCHIATA.

Family DENDRODORIIDÆ.

Genus **Dendrodoris** Ehrenberg, 1831.

Dendrodoris Ehrenberg, Symbolæ Physicæ, 1831, not paginated, but on p. 94. Type by subsequent designation *Dendrodoris lugubris* Ehrenberg (Gray, Proc. Zool. Soc. Lond., 1847, 164).

Rhacodoris Morch, Journ. de Conch., 3, Ser. iii, 1863, 34. Type by original designation, "*Doris laciniata* Cuvier".

Doridopsis Alder and Hancock, Trans. Zool. Soc. Lond., Vol. v, Pt. 3, 1864, 125. Type by original designation, *Doridopsis gemmacea*.

Haustellodoris Pease, Amer. Journ. Conch., v, 1871, 299; for the *Doridopsis* of Alder and Hancock.

Dendrodoris davisi, sp. nov.

(Plate lvi, figs. 13–14.)

Animal oblong-ovate, soft with wide crenulated mantle. The whole dorsal surface is covered densely with large, soft, raised pustules, and smaller ones between them. Rhinophores conspicuous, fat and club-shaped, situated close to the anterior margin, and retractile into large, rounded, somewhat raised cavities. Branchial opening wide, circular, and slightly raised. Gills wide, bushy, placed well towards the posterior margin, five in number, retractile to about the cavity edge. The anus is situated at the end of a tube, which protrudes between the two posterior gills. Foot very broad, grooved at the anterior end, upper lip joined to small, circular, pore-like mouth. Oral lobes flat, inconspicuous, close together, merely folds.

The general colour of the animals varies from pale yellow to vivid reddish-orange, but a rich orange is the usual colour. The whole central dorsal surface is a very dark greenish-brown with dashes of orange, red, dark brown and white upon it. The orange pustules seem to be ringed with dark brown. A dense ring of dark markings surrounds the dorsal central portion. In some specimens white lines surround the pustules. These are particularly in evidence after the slug has been in captivity for some time. Dark brown irregular lines and dashes extend from the central dorsal surface towards the margins. The margins are light orange. Rhinophores orange, white-tipped. Gills yellow to pale orange, usually a little paler than the ground colour of the individual specimen. Edge of branchial cavity whitish.

The undersurface is the same ground colour as the dorsal surface, but sometimes a little paler. Reddish-brown patches and oblong spots are on the undersurface of the mantle. These are very faint in some specimens. The markings form irregular bands from the edge of the foot to the mantle margins, with small brown spots between them. Mouth and oral tentacles pale. Foot pale orange.

Length of animal 36 mm., breadth 21 mm. Type specimen, Australian Museum collection.

Locality.—Specimens of this species have been collected under stones in rock pools in the last few years at Long Reef, and Pittwater, near Sydney (Mr. G. P. Whitley and Mr. M. Ward), Pussy-cat Bay, near Cape Banks, Botany Bay (Mrs. W. J. Dakin and self), and at Bulli, N. S. Wales (Mr. Consett Davis, Mr. F. D. McCarthy, and self).

This little slug, one of the most noticeable and showy found in New South Wales, resembles somewhat *D. nodulosa* Angas, specimens of which I have seen alive, but differs from it in being much more pustulose generally, and particularly in the central dorsal surface. That portion of *D. nodulosa* is entirely smooth and this character is constant.

The species varies in its ground colour. Specimens brought from Bulli by Mr. McCarthy ranged from pale yellow to rich orange-red. The smaller ones were the paler, and it was noticed that the orange-red ones faded to orange when deprived of nourishment. The gills had the ground colour of the individual. The white markings which were scarcely visible when first removed from their natural surroundings increased when the animal was in stale water.

Dendrodoris albobrunnea, sp. nov.

(Plate lvi, figs. 9–10.)

Animal elongate-oval in shape, smooth and soft with no trace of large pustules, slimy. Mantle wide, somewhat crenulated. Rhinophores laminated, set well forward towards the anterior end, retractile into rounded non-raised cavities. Gills seven, bushy, retractile into a rounded cavity near the posterior margin. A thick tubular anus protrudes between the two posterior gills.

Foot large, reaching well down towards tail tip. Anterior portion grooved, upper lamina joined to mantle. Mouth a fine pore. Oral tentacles indistinct, in some specimens represented by small folds.

Internally, the slug has all the characters of a typical *Dendrodoris*.

In life the animal varies from a dirty white to yellowish-cream, especially round the margins of the mantle and foot. The whole dorsal surface is covered with conspicuous brown spots of irregular size, intermingled with fine brown speckling and dashes. Here and there are light grey patches, surrounded by small brown spots. The large brown spots are arranged in more or less regular lines from the anterior margin to the posterior. The rhinophores are yellowish streaked with brown and with white tips. Gills are light yellow marked with brown.

The foot is slightly paler than the upper surface, with a pale yellowish margin. A series of small, dark, irregular sized spots and dashes surround the foot on the mantle and extend up the sides of the foot. There are a few indistinct spots towards the mantle margins. The sole of the foot is unmarked.

Length in spirit of a well preserved specimen, 65 mm., breadth 30 mm. Type specimen, Australian Museum collection.

Locality.—Six specimens were found under coral on North-west Islet, Capricorn Group, Queensland, in 1931, by Mr. G. P. Whitley, who made colour notes on it in life. The specimens have preserved very well, and even now their colouring is practically the same as in life.

Family DORIDIDÆ.

Genus Discodoris Bergh, 1877.

Discodoris Bergh, Jahrb. deut. malak. Gesell., 1877, p. 61. Type designated by O'Donoghue (Trans. Roy. Canad. Instit., No. 34, Vol. xv., Pt. 2, 1926, 207) *Discodoris boholiensis* Bergh, Malac. Unters. Semper. Reisen Archipel. Phillip., 1877, 519. Bohol, Philippines.

Discodoris palma, sp. nov.

(Plate lvi, figs. 11–12.)

Animal roundly-ovate, large and soft, with a wide, crenulated margin. Whole surface densely covered with minute pustules, especially in the central dorsal surface. Rhinophores long, retractile into slightly raised pustulose cavities. Gills retractile into a rounded cavity, edges not definitely divided into lobes but only suggested, six in number. Anus situated between the posterior two.

The foot is of medium breadth, upper edge deeply grooved. Oral tentacles long and thin, conspicuous.

Radula is a ribbon-like strip, 3 mm. in length, consisting of about twenty-one rows of numerous, long, thin, sharply curved teeth.

The jaws are minute, 1 mm. long, and yellowish.

The general colour of the animal is a very pale light grey-fawn on the dorsal surface, with darker irregular patches of speckling scattered over it, especially thick round the edge of the central dorsal portion, and becoming smaller but denser towards the margins. The central area is darker in colour than the mantle. Rhinophores are pale at the base, dark towards the middle, and have white-tipped tops. The gills are pale yellow-buff with brown speckling, their stalks pale grey streaked with brown.

The undersurface is pale bluish-grey, with small, dark, chocolate-coloured, irregular-sized spots scattered over it and fine minute specks between them. These spots are more dense on the mantle round the foot. Some spots are scattered over the centre of the foot.

Length of animal 50 mm., breadth 34 mm. Type, Australian Museum.

Locality.—Pussy-cat Bay, near Cape Banks, Botany Bay, N. S. Wales (coll. self), under stones at low tide, Feb., 1932.

This is the first time the genus *Discodoris* has been recorded from N. S. Wales.

Family POLYCERIDÆ.

Genus **Nembrotha** Bergh, 1877.

Nembrotha Bergh, Semper Reiss., Heft xi, 1877, p. 450: ibid., xvii, 1890, p. 980. Type designated by O'Donoghue, *Nembrotha nigerrima* Bergh (Journ. Linn. Soc. Zool., xxxv, 1924, p. 567).

Small limaciform animals, with smooth bodies, rather raised in the central region. There is no definite dorsal margin between the back and the sides, although some species may show a suggestion of it. Body without dorsal and frontal appendages. Foot narrow, elongated into a narrow tail posteriorly, bluntly rounded at the anterior end. Rhinophores retractile. Branchiæ non-retractile, 3–5 in number, strong and stout, situated about the centre of the dorsal surface and almost surrounding the anus. Oral tentacles small. Radula very narrow, with square central tooth and large hamate lateral tooth on each side; the remaining teeth are generally squarish plates without hooks. No jaws as a rule, but minute ones may be present in some species. Hermaphrodite gland spread over the liver.

This genus and its nearest ally, *Trevelyana* Kelaart, form a small group of the Polycéridæ, and are recorded chiefly from the Indo-Pacific, where they are found between tides under stones. *Nembrotha* differs from *Trevelyana* in having only four to five gills instead of the larger number, not less than ten, of the latter genus. Internally, instead of the hermaphrodite gland being divided into globules as in *Trevelyana*, it is spread over the liver. They also differ in the radula.

O'Donoghue (Journ. Linn. Soc. Lond. Zool., Vol. xxxv, No. 237, 1924) suggests that there may be a possibility of *Nembrotha* Bergh, 1877, being replaced by *Angasiella* Ang. and Cross., 1864. The form described by the latter is very much like those in Bergh's genus, and Bergh himself includes it as a doubtful member of the genus. So far I have not seen a specimen of the genus *Angasiella*, so for the present am unable to follow up this suggestion.

Basedow and Hedley (Trans. Roy. Soc. South Australia, Vol. xxix, 1905) record one species of *Nembrotha* (*verconis*) from St. Vincent Gulf, S. Australia, and O'Donoghue (Journ. Linn. Soc. Lond. Zool., Vol. xxxv, No. 237, 1924, p. 521)

includes *Nembrotha purpureolineata* O'Don., a slate-grey species with purplish-brown bands, in his report on the Opisthobranchs from the Abrolhos Is. The following species adds another one to the Australian list.

Nembrotha livingstonei, sp. nov.

(Plate lvi, fig. 15.)

Animal small, with a smooth limaciform body, raised in the centre, produced to a tail posteriorly, and rounded anteriorly. Rhinophores retractile into raised cavities with lobes, inserted at the edges of a light-coloured, star-shaped patch. Branchiæ strong, stout and stumpy, four in number, sparsely foliated, situated almost in the centre of the dorsal surface, and forming a semicircle round the anus.

The general colour of the animal is dark cocoa-brown, with small irregular sized rich indian red spots scattered over the sides and dorsal surface. These appear smaller in size, though not less numerous, near the branchial area and towards the central dorsal area. The rhinophores are white at their base, with electric blue tips, and are situated on the sides of a conspicuous star-shaped patch of pale yellow, a portion of which extends down to the anterior frontal margin. The branchiæ are cream on the inner side, and on the outer side brown. Their bases are electric blue. The large area on which they are placed is yellow like that round the rhinophores, but it has an electric blue border surrounding it. The foot is a dirty white. The narrow radula is light straw coloured. No trace of jaws could be found.

The specimen, which has become much wrinkled in preservation, is now 16 mm. long, 9 mm. high to the base of the branchiæ, and 6 mm. broad. Type specimen, Australian Museum.

Locality.—A single specimen collected at Broome, West Australia, by Mr. A. A. Livingstone, who noted its colours in life. The ground colour of the animal has not faded to any extent, but the red spots are now paler and the electric blue has faded to a dirty white.

EXPLANATION OF PLATE LVI.

Aglaia taronga Allan.
Fig. 1.—Animal.
Figs. 2-3.—Inside and outside view of shell.

Pleurobranchæa dorsalis Allan.
Fig. 4.—Animal.
Fig. 5.—Egg-girdle and young larva.

Aglaia sanguinea Allan.
Fig. 6.—Animal.
Figs. 7-8.—Inside and outside view of shell.

Dendrodoris albobrunnea Allan.
Figs. 9-10.—Dorsal and ventral view.

Dendrodoris palma Allan.
Figs. 11-12.—Dorsal and ventral view.

Dendrodoris davisi Allan.
Figs. 13-14.—Dorsal and ventral view.

Nembrotha livingstonei Allan.
Fig. 15.—Side view.

A RE-EXAMINATION OF TWO OF RAMSAY'S TYPES OF NEW GUINEA OWLS.

By

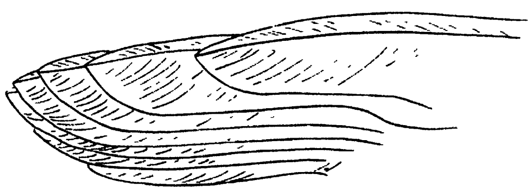
J. R. KINGHORN, C.M.Z.S.,
Zoologist, The Australian Museum.

Ninox undulata Ramsay.

(Figures 1-2.)

Ninox undulata Ramsay, Proc. Linn. Soc. N.S.W., iii, 1879, p. 249.

In describing this species, Ramsay referred to its close relationship to *Ninox rufa* Gould,[1] but stated that it "is altogether smaller". After examining the type and comparing it with two specimens of *N. rufa* from Cooktown, Queensland, I find that the differences between them are so minute as to be negligible. The wing formula given by Ramsay is not quite correct; in fact it is rather misleading. An examination shows that the fifth primary is the longest, followed in order by the fourth, sixth, and third, while the second and seventh are almost equal, reaching to a point about midway between the tip of the first and fifth. The secondaries extend a little beyond the level of the tip of the first primary. The wing formula of the two specimens of *N. rufa* agrees with that of Ramsay's *N. undulata*, but the secondaries are distinctly longer. One of the Queensland



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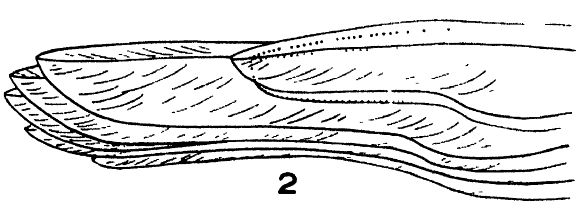

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Figures 1-2.
Figure 1.—Wing formula of *Ninox undulata* Ramsay, from type.
Figure 2.—Wing formula of *Ninox rufa* Gould. Specimen from Cooktown, Queensland. The second primary, half-grown, is shown by dots.

[1] Gould.—Proc. Zool. Soc. Lond., 1846, p. 18.

specimens is a male, in which the second primary of each wing has been lost through moult, and is replaced by a half-grown one as shown in the accompanying figure.

The measurements of the three specimens are given below, and in making them I have followed the methods adopted by Baldwin, Oberholser and Worley,[2] except in one or two instances where a better comparison can be made with the type, in which case I have followed Ramsay.

	Type.	Cooktown Specimens.	
		♂	♀
	mm.	mm.	mm.
Wing	300	325	340
First primary	161	160	170
Third primary	230	240	270
Tail	215	223	255
Central tail feather	200	210	220
Tarsus	50	49	51
Middle toe	34	34	34
Middle claw	27	27	27
Depth of bill at nostril	20	21	27
Width of bill at gape	32	34	35
Length of bill from frontal tuft ..	34	36	40

Some years after describing *N. undulata*, Ramsay gave a description of characters and measurements, in inches, of a series of specimens of *N. humeralis* from Queensland and New Guinea, and preceding this was a description of *N. rufa.* An examination of his specimens, and a comparison of their characters with his descriptions were interesting, because, while he called attention to the relationship of *N. rufa* to *N. strenua* Gould,[4] and the similarity of *N. humeralis* to *N. rufa*, he evidently did not go far enough to establish their exact status, and he left them as distinct species. Salvadori[5] placed *N. undulata* Ramsay in the synonymy of *N. humeralis* Hombr. and Jacq.,[6] and as the latter is now regarded as identical with *N. rufa* Gould, it follows that *N. undulata* also comes under that name.

Ninox albomaculata Ramsay.
(Figures 3-5.)

Ninox albomaculata Ramsay, Proc. Linn. Soc. N.S.W., iii, 1878, p. 249.

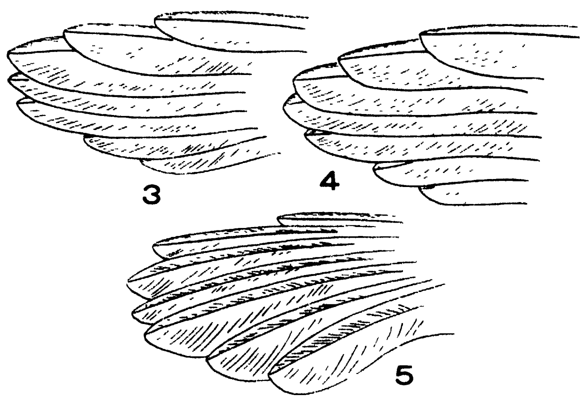
Shortly after Ramsay described this owl as new, Salvadori,[7] who had received an early copy of the paper, wrote: "The description of this bird agrees with that of *Ninox assimilis* Salvad. et d'Alb."[8]

[2] Baldwin, Oberholser and Worley.—Cleveland Mus. Nat. Hist., Sci. Pub., ii, 1931.
[3] Ramsay.—Austr. Mus., Cat. 4, Pt. 2 (2nd edition), 1898, pp. 27-29.
[4] Gould.—Syn. Birds of Austr., 1838, p. 49.
[5] Salvadori.—Ornith. Papuasia e Molucchi, i, 1880, p. 84.
[6] Bonaparte.—Consp. Gen. Avium, i, 1850, p. 40.
[7] Salvadori.—The Ibis (4), iii, 1879, p. 319.
[8] Salvadori et d'Albertis.—Ann. Mus. Civ. St. Nat., Genova, 7, 1875, p. 809.

This opinion evidently was not acceptable to Ramsay, who later included it, under the name of *N. albomaculata*, in his list of New Guinea birds collected by Mr. A. Goldie.[9] In the year 1890 Salvadori[10] placed it in the synonymy of his *Ninox assimilis* as ? *Ninox albomaculata* Ramsay; and discussed the affinities of *N. assimilis* generally, giving the differences between it and *N. boobook*; but while he queried *N. albomaculata*, he evidently entertained little doubt that it would prove to be his *N. assimilis*.

Ramsay's description was all Salvadori had to work on, and, while that description suggested a close affinity between the two species, it was not as accurate as it should have been. I admit a close relationship between *N. albomaculata* and *N. assimilis*, but after an examination of a large series of owls, I regard Ramsay's *albomaculata* as a subspecies of *N. boobook*. The colour markings from above immediately suggest *boobook*, while the more definitely streaked undersurface resembles a typical *ocellata*, but it can be quickly separated from the latter by the absence of spots on the hind neck—a character typical of *ocellata*.

It is interesting to note that the type of *albomaculata* is similar in many respects to a previously unnamed bird in the Museum collection from "Northern Territory of Australia", but Ramsay's bird has less conspicuous bars on the primaries and tail feathers, while the mesial streaks on the abdominal feathers are narrower. The under-wing coverts are identical, while the rest of the colour and markings are very similar. The north Australian bird is a little longer than the New Guinea one and has a tail of 175 mm., and wing 275 mm., as against tail 153 and wing 265 mm. in the latter. There is no doubt in my mind that the former is *Ninox connivens peninsularis* (it is larger than *N. connivens occidentalis* from north-west Australia), and that it is closely related to the New Guinea bird, which I now regard as *Ninox boobook albomaculata*.



Figures 3-5.

Figure 3.—*Ninox albomaculata* Ramsay, from type.
Figure 4.—*Ninox bobook* Latham, a typical specimen.
Figure 5.—*Ninox connivens* Latham, *peninsularis* Salvadori, from Cape York, Queensland.

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[9] Ramsay.—Proc. Linn. Soc. N.S.W., iv, 1879, p. 96.
[10] Salvadori.—Ornith. Papuasia e Molucchi, 1890, p. 81.

Ramsay's type specimen is far from being a good skin; the head is crammed into the neck, and cannot be straightened out, making it impossible to take a correct measurement of the total length, which Ramsay gave as 15·5 inches, but which I cannot make quite 14 inches. Figures showing the wing formula and the comparative extent of the tips of the first to seventh flight feathers in Ramsay's type of *albomaculata*, a typical *N. boobook*, and *N. connivens peninsularis*, are shown on the previous page.

RE-DESCRIPTION OF Ninox boobook albomaculata RAMSAY.

Above, dusky brown, head darker, uniform, some of the feathers of the hind neck having somewhat light margins. Scapulars brown like the back, some of the feathers bearing large white spots. Wing coverts brown, the greater and median series with conspicuous white spots. Primary coverts darker than the back, with no indication of lighter cross-bars. Quills dark brown, with lighter bars on the inner webs, the outer webs margined with fulvous, forming spots on the third, fourth and fifth. Rump inclined to rufous. Tail brown like the back, all the feathers being barred with a paler brown, those on the inner webs terminating in whitish spots. Lores and frontal plumes whitish, sides of head fulvous, narrowly streaked with brown; ear coverts dark brown. Breast feathers white with a broad, mesial, rufous streak.

Abdominal feathers mainly white with a narrow rufous streak extending to the tip. Leg feathers strongly rufous, some with darker streaks. Under-wing coverts dark fawn, with broad dark streaks at the tip, the whole area resembling, in colour, that of the breast.

Measurements.—Total length, 350 mm., wing 265 mm., tarsus 38 mm., tail 170 mm., bill from nostril 16 mm., bill from cere 18 mm., depth of upper mandible at nostril 11 mm., width of bill at gape 28 mm., length of lower mandible from gape 28 mm., length of upper mandible from gape 33 mm., culmen 30 mm.

Type from Laloki River, near Port Moresby, Papua, No. A 2227, Australian Museum collection. The specimen was collected by Mr. A. Morton, who accompanied Mr. A. Goldie, in 1877.

STUDIES ON FRESH-WATER SPONGES FROM AUSTRALIA. No. I.

By

N. Gist Gee,

Rockefeller Foundation, Peiping, China.

(Plate lvii, and Figures 1–4.)

A NEW LOCALITY IN AUSTRALIA FOR EPHYDATIA MULTIDENTATA (WELTNER).

(Plate lvii.)

In the writer's article on the fresh-water sponges from Australia and New Zealand[1] *Ephydatia multidenta* was recorded (pp. 25, 53) from Burnett River, Queensland, and from Cooper's Creek in south Central Australia.

In October, 1931, the Director of the Australian Museum submitted a small fragment of fresh-water sponge which had been donated to the Museum for determination. With the sponge was a good photograph and also the following notes: "The fragment of sponge is from a growth of considerable size donated by Mr. L. A. Ducker (regd. Z 2646); the specimen was found on the submerged root of a tree in a creek at Merigol, Wanko Siding, near Charleville, Western Line, Queensland, and was received at the Museum alive on the 23rd September, 1931."

The excellent photograph, which is published with this note, gives a splendid idea of the size, the habit of growth, the irregularities of the surface and of the numerous pores upon the surface of the sponge. Our small dry specimen is a light yellowish-brown, and the gemmules, which are very numerous and are crowded throughout all parts of the specimen, are somewhat lighter in colour than the sponge itself.

In order that the records may be kept up to date, it is desired that the reports of specimens of these sponges found be reported. It is hoped that scientists and collectors in all parts of the country will keep a keen lookout for these sponges when collecting in fresh-waters.

A NEW FRESH-WATER SPONGE FROM AUSTRALIA.

(Figures 1–4).[2]

The Records of the Australian Museum, Vol. xviii, No. 2, pp. 25–62, January 15, 1931, contain a paper by the present writer on the subject of the fresh-water

[1] Gee.—Rec. Austr. Museum, xviii, 2, 1931, pp. 25-62.

[2] The drawings have been prepared by the artist of the Department of Biology of Yenching University, Peiping, China, under the direction and with the assistance of Dr. C. F. Wu. I am much indebted to them for the excellent results which have been obtained.

sponges known from Australia up to that date. Since that time the Museum has kindly sent small bits of the sponges as they were collected, and the following notes describe a new species which has just been received.

Spongilla multispinifera, sp. nov.

(Figures 1-2.)

Historical Statement.—Numerous small specimens of this sponge were collected during the month of February, 1932, by Mr. M. E. Gray from Heathcote Creek, near Waterfall, about twenty miles south of Sydney, N. S. Wales.

Habitat.—The sponges were taken from the undersides of small sandstone rocks in running water. They were all collected within a radius of from six to eight feet.

General Characteristics.—All of the specimens sent me were growing in very small, thin, more or less irregular circular patches of only a few millimetres in diameter. They are smooth on the surface and the oscula are inconspicuous. The area where the sponges were found was periodically searched over a period of two months, and during that time no specimens of great size were observed.

Colour.—When fresh, the sponges were of a "dirty cream" colour, or in some cases they were originally "lettuce green", this colour being without doubt due to the presence of green algæ growing symbiotically within the sponge.

Structure.—The sponge colonies are so small that they present no characteristic, clearly defined arrangement of the spicule rays. The sponge body seems to be made up of a rather thickly woven lot of spicules massed together and held tightly and firmly in position by a good supply of spongin.

Skeleton Spicules.—The skeleton spicules are curved, are larger in the centre and gradually tapering toward their ends; now and again thicker spicules, which are more nearly straight, are found, and these are generally almost uniform in diameter up to near the ends, where they become abruptly sharp pointed. The spicules are all thickly covered with conspicuous spines right up to their tips in most cases; a few spicules have their sharpened tips free of spines for only a very short space; in a few cases we have found the spines to become lengthened at a short distance

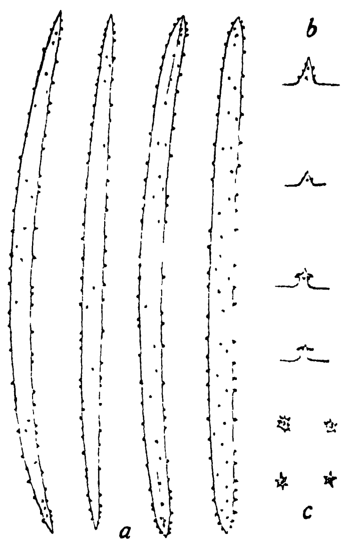


Figure 1.
Spongilla multispinifera, sp. nov.

a.—Two general types of skeleton spicules, one with gradually sharpened ends, the other with abruptly sharpened ones. The spicules of both types are covered all over with spines, even to their very tips.

b.—Enlarged drawings of several of the different kinds of spines found on the skeleton spicules. Some are cone shaped with fine spines upon them and others have a row of fine spines forming a circle near their tips.

c.—These drawings show the spines of this second kind as they appear when looked down upon from above.

from the end of the spicule, though usually they become somewhat smaller in size. The spines (Fig 1, *b*) are very variable: some are simple cone-shaped ones with very sharp points; others seem to bear a few minute spines near the outer end of the spine and from that point the size of the spine becomes much reduced, and it ends in a small spine much thinner than the other portion of the spine; some of the others seem to end more or less as knobs or with flattened tips. The spicules vary in length from about 229 to 280 microns, and from 9 to 16 microns in thickness.

Flesh Spicules.—There are no flesh spicules present in this sponge.

Gemmules.—Unfortunately there were very few gemmules present in the specimens sent me. Those found were a rather dark brown in colour when mature, and in every case they were located at the base of the sponge. They occur singly, and are thickly covered with a granular coat in which are embedded large numbers of coarse gemmule spicules mingled with quite a number of skeleton spicules all tightly bound together. This mingling of the spicules holds the gemmules strongly in place, and it was not easy to tease them out of the sponge without crushing them. The arrangement of the spicules around the gemmule is irregular; in the main they are tangentially placed, though in the outer portion of the coat they are found at all kinds of angles, some of them even being perpendicular to the surface of the gemmule. The pore-tube is simple and opens upon the surface of the coat. The gemmules also vary a good deal in diameter due to the great variation in the thickness of the spicule layer covering them. The smallest gemmule, including its covering, measured about 340 microns, while the larger ones were as much as 510 microns or even more.

Gemmule Spicules (Fig. 2).—The gemmule spicules are usually gently curved, sometimes straight, rod-like structures in general shape; they are of almost uniform diameter, though in many cases the concentrating of the heavy spines around the ends of the spicules may cause them to become enlarged into club-like structures with both ends enlarged alike. Sometimes the spicule may terminate in a sharp point or spine or in a knob-like structure, or it may end in one of the spines similar to those which occur on other parts of the spicule. These spines are straight and, as a rule, are perpendicular to the length of the spicule; they are much more abundant near the ends, while frequently the central portion of the spicule may have only very few and much smaller

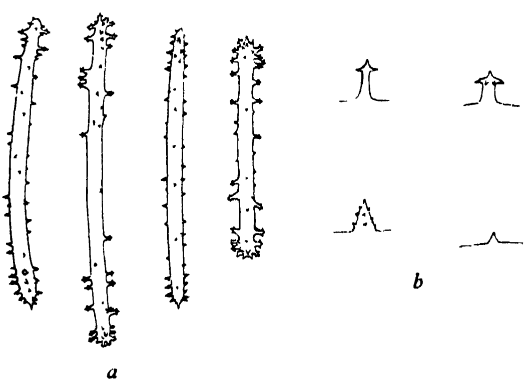


Figure 2.
Spongilla multispinifera.
a.—Four different gemmule spicules, showing differences in shape and length. Often club-shaped spicules are formed by the massing of the larger spines around the ends of the spicules.
b.—Various types of spines on the gemmule spicules. These spines are similar in every way to those of the skeleton spicules, but they average a good deal larger.

spines than those near the ends; this is not always true, however, for sometimes the spines are scattered more abundantly over this part of the spicule also. The spines (Fig. 2, *b*) are large and thick, some of them simple, straight, smooth and cone-shaped, sharpened at their upper ends, often these have minute spines on them. Most of them, however, are of a rather peculiar type; near their ends they become very much decreased in size and terminate in a very much attenuated spine, out of all proportion to the size of the rest of the spine; just where the sudden decrease in size takes place in the heavy spine are a few very minute spines causing that part of the larger spine to appear to be swollen out a bit—these small spines are at right angles to the larger spine. This is the typical form of the spines on the gemmule spicules, though other variations of several kinds occur in addition to these. I could find none of the spines divided at their ends such as are characteristic of *Spongilla proliferens*.

The gemmule spicules range in length from 86 to 122 microns, and they have a diameter of from 4 to 6 microns in the centre.

Type.—This species is described from small specimens sent to me by the Trustees of the Australian Museum. The type is No. 55043 in the collection of the writer; a slide from, and portion of, the type is being deposited with the Australian Museum, which also holds the other specimens collected at the same time. The writer is very much indebted to the authorities of the Australian Museum and to Mr. Gray for the opportunity to study this sponge.

Distribution.—The sponge is as yet known only from the type locality, Heathcote Creek, near Waterfall, near Sydney, N. S. Wales, where it was collected by Mr. M. E. Gray.

Remarks.—Of the fourteen named fresh-water sponges recorded from Australia and New Zealand in the article referred to in the first paragraph of this paper, only five are *Spongillas*, the others being the peculiar type of *Ephydatias*, up to the present known only from Australia, with the rotules uniformly unequal.

Two of the five species of *Spongillas* are the cosmopolitan species, *Spongilla lacustris* and *Spongilla fragilis*; neither of these two species was represented in the materials from Australia which the writer has studied, but were included in our list because of the records of other previous students of Australia's fresh-water sponges. Both of these forms have smooth skeleton spicules.

A third form, called a variety of *Spongilla lacustris*, that is var. *sphærica*, is a very doubtful one and was included in our list simply to make the record as complete as possible. The writer still considers the identification of a sponge from its skeleton spicules alone without either flesh spicules or gemmules as a *new* form as a very doubtful procedure and does not accept Lendenfeld's variety, *sphærica*, as final. The skeleton spicules of this sponge in most cases bore small spines. On page 62 of the paper referred to above, three additional lots of skeletal spicules are figured, but no identifications are attempted since the necessary additional data for such determinations are not available.

This leaves, then, two characteristic Australian *Spongillas*, *S. sceptroides* and *S. botryoides*, for comparison with this new sponge described above. Both of these also have spined skeleton spicules, but in neither case are there so many spines, nor do those present the peculiar characteristics of this new sponge just

described. Then, too, the spines on the spicules of the other two already recorded species are lacking on the ends, whereas in this new one they usually extend right on to very near the points.

The most marked differences, however, occur in the gemmule spicules. Those of *S. botryoides* have the simple spines grouped near their ends, while the middle portion of the spicule is free as is shown in the illustration (Figure 3). The spicules of *S. sceptroides* also have simple, thin, cone-shaped spines with very

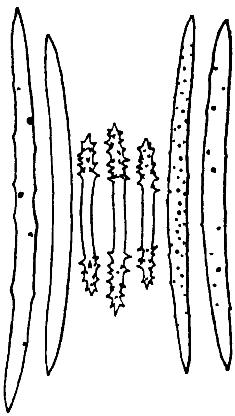


Figure 3
Spongilla botryoides,
Haswell.

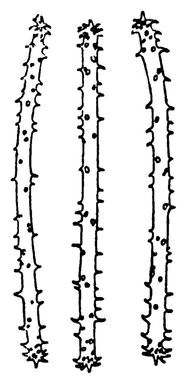


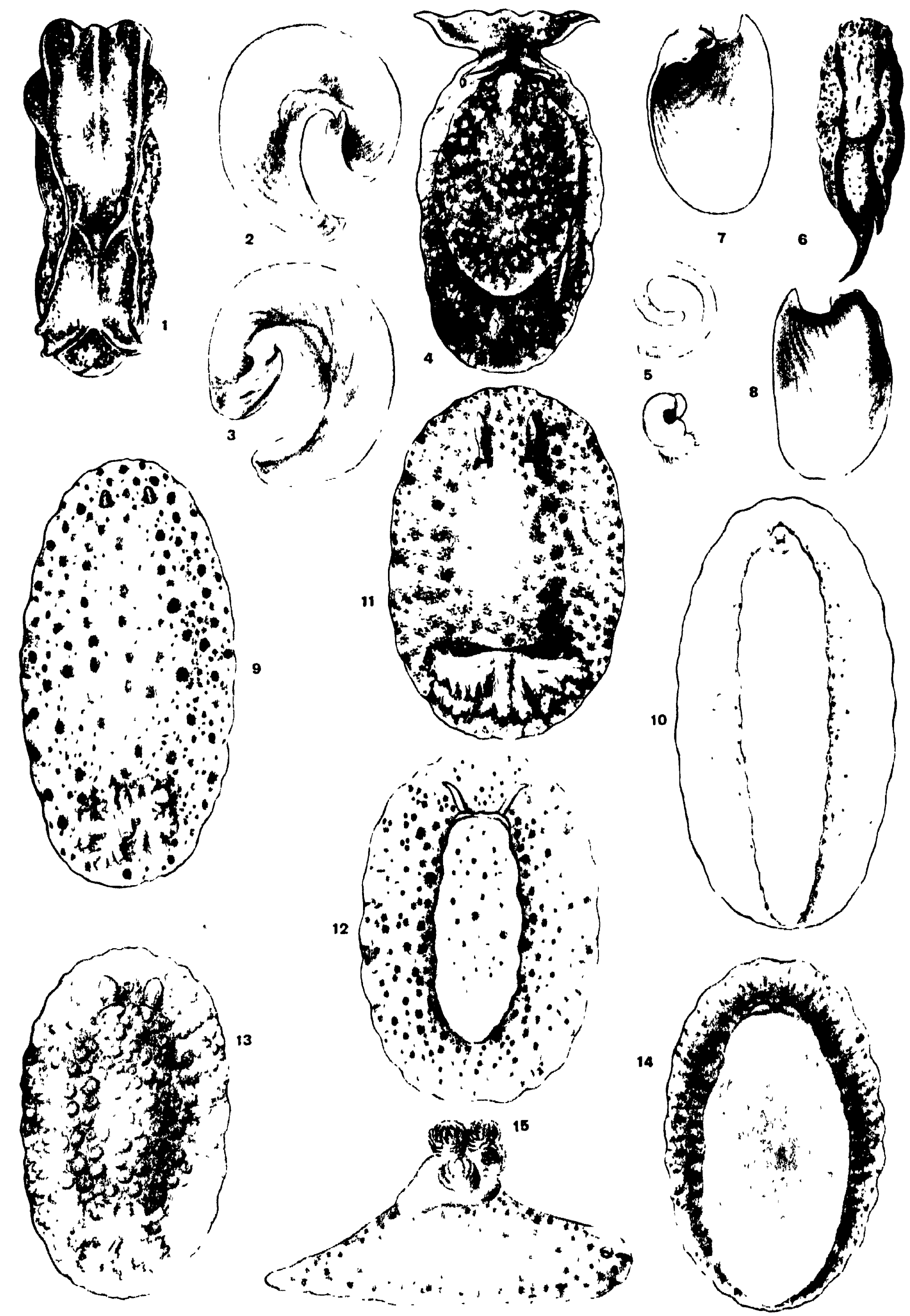
Figure 4.
Spongilla socptroides,
Haswell.

sharp points which are distributed over the entire length of the spicule; the spicules usually terminate in prominent spines, and the spines around the ends of the spicules are recurved, while those of the middle portion are somewhat smaller and are placed at right angles to the axis of the spicule (Figure 4).

This new sponge, *S. multispinifera,* has been carefully compared with all available other *Spongillas* with spined gemmule spicules of this general type, and it is found to be quite unique. It is therefore placed as a new species.

EXPLANATION OF PLATE LVII.

Ephydatia multidentata (Weltner). Specimen attached to submerged root of a tree, Merigol, Wanko Siding, near Charleville, Queensland.



JOYCE K. ALLAN, del.

G. C. CLUTTON, photo.

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